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THE ISLAND OF MALEKULA, NEW HEBRIDES: *A paper read at the Evening Meeting of the Society on 21 November 1932, by*

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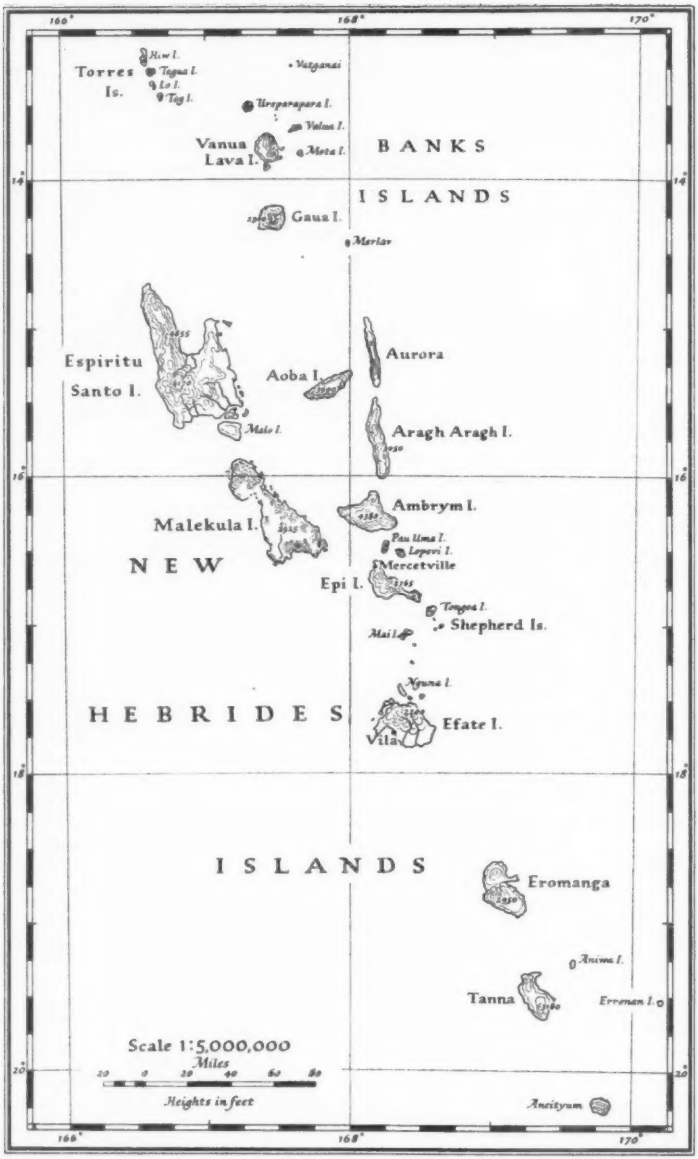
IN 1927, while working out a collection of insects in the Natural History Museum, which I had made on the Society Islands and Marquesas Islands during the *St. George* Expedition, I discovered that there was very little entomological material from the New Hebrides in our national collection. We needed this material to link up our knowledge of the insect fauna of New Guinea and the Solomon Islands with that of Australia and the groups of the South Pacific, and to aid in working out some unnamed species; I therefore planned to visit that group. In 1928, having obtained grants in aid of the expedition, I left England in November and spent two years in the New Hebrides, devoting one year to Malekula, and the remainder of the time to four other islands, with six weeks on Vanua Lava, Banks Islands. I should like to take this opportunity of recording my gratitude to the Royal Society, the Trustees of the Percy Sladen Trust, and of the British Museum of Natural History for their financial aid.

The New Hebrides Islands lie between Fiji and Australia, in the same latitude as North Queensland, and extend for about 450 miles from north-west to south-east. There are over thirty islands in all, including rock islets and coral atolls, twenty of these are inhabited and there are twelve main islands. Politically they form one group with the Banks Islands to the north, but geographically the two groups are quite distinct. There are also such important differences between the northern and southern islands of the New Hebrides that in future those south of Efate will probably be considered as a separate group. The group is served by two shipping lines—French and British—running every five or six weeks respectively from Sydney to Vila, on Efate, the capital; while inter-island trading steamers collect cargo, principally copra, from the plantations. Communication is therefore irregular, and small schooners and even motor-launches are very often the only means of getting to one's destination.

The Government is a Condominium, French and British; but on the southern islands at the time of my visit there were no French and only ten British settlers. Only comparatively small areas on any of the islands are under



New Hebrides and Banks Islands

cultivation. The northern islands are smothered in very dense bush, with low shores fringed with coral, and some marshy areas and small mangrove swamps at the mouths of rivers. There are low coastal hills, chiefly of raised coral; and the highest mountain is less than 6000 feet. The climate is considered very unhealthy: not because the temperature is extremely high, for it varies from 84° to 98° for three parts of the year; but the percentage of moisture is excessive, and the air is frequently laden with volcanic dust from the active volcanoes of the group, making conditions very depressing. Malaria is very prevalent, and there is a great deal of blackwater fever, especially in the hot, rainy season from December to April. The temperature of the southern islands is 10° lower. The forest is less dense, the soil drier, being porous in some localities; and there are high, open plateaux with fresh, invigorating winds. The general conditions are delightful, and there is very little malaria. The collection of insects is not worked out and will take some years to complete, but it shows that there is affinity between the insects of the northern islands and those of Papua and North Queensland; while those of the southern islands have more affinity with Fiji and Samoa, and the south-west of Australia.

Seven months of the first year, February to September, and five months of the second year, January to May, were spent on Malekula. This is the second largest island of the group, 46 miles long and about 26 miles broad. It is densely forested from the shore-belt to the tops of the hills; the trees are not lofty, but there is a peculiarly dense type of undergrowth knit together by various species of lianes, *Ipomea*, wild yams, etc. The only cultivated areas are on the coast; and the only roads are through plantations. The interior is a medley of short, low ranges with small valleys between; except that to the east behind Pangkumu Bay is a low-lying marshy area; and to the south is another flat, low-lying area drained by the river Ureymus. In the north-west are totally different conditions, as the whole of that side has been raised again and again, forming remarkable series of coral plateaux on which are small hills of curious shapes. The highest terrace is about 2000 feet and is south of the river Malua: on these terraces there is very little bush, as they are periodically burnt over by the natives; but they are entirely covered by a very high grass, *Miscanthus japonicus*, which grows in large tussocks. There are no large rivers on Malekula: the longest is Ureymus, rising in the centre of the island and flowing south and then south-west, joining the sea near Tomman Island.

Owing to the unfriendly relations between bush tribes, those native trails which do exist are only known to the inhabitants of the particular villages which they serve; and as the native population is dying out so rapidly, such trails are overgrown and in parts obliterated. Even where a trail is considered by natives to be clear and direct it is not so in reality, for it doubles and twists in an incredible fashion, very often turning away from its objective. So that five or six hours may be spent in reaching a locality only 3 miles inland, and at least an hour a mile must always be reckoned when travelling in the bush. The superstitions of the natives also create many difficulties.

The natives of Malekula are Melanesians and extremely primitive: and they are as yet unaccustomed to white people exploring the bush. Mr. McPhail, who was surveying the island in 1926, made several bush journeys, but unhappily died of blackwater fever before he had completed his work. In 1927 Mr.

Deacon, the brilliant young Cambridge anthropologist, also travelled about in the interior, but he too died on the island. No other white men have spent so much time in the bush nor encamped inland since 1873, when Ross Lewin, a notorious sandalwood trader, with an escort of a hundred armed natives crossed Malekula from south to north in five days. Mr. McPhail and Mr. Deacon met with no hostility from the bush tribes, but their untimely deaths made it harder for me to induce native guides to accompany me, because, to a native, death is always due to supernatural interference. Since however I happened quite unwittingly to earn a reputation for being a kind of super-

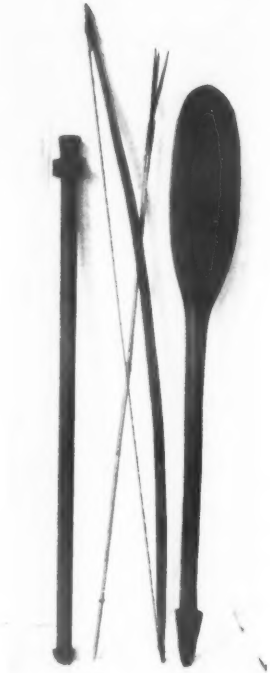
bush-devil, this aided me in carrying out most of my projects. Some of the bush tribes are commonly reported to be treacherous and hostile to white men. When the back history of these islands is remembered, and all that the natives suffered at the hands of sandalwood traders, whalers, trader-missionaries, and recruiters, it would not be surprising if the Malekulans were vindictive; but when they understood my work I never even at the beginning found the bush tribes unfriendly.

My first headquarters were at Unua, on the east coast, where a Presbyterian mission-house was kindly put at my disposal during the temporary absence of

New Hebrides: typical landscape of the southern islands

Typical bush of the northern islands

Ringapat, King of the Big Nambas tribe



Weapons of the cannibal tribes

Typical Big Nambas boy

the missionary. From there I collected for about 5 miles along the coast and 3 miles inland. The mission-house stands about 90 feet above the sea on a cliff of raised coral; the present reef extending about 100 yards from the shore with living coral at the ocean edge. A trail along the shore can be followed at low tide to Pangkumu Bay, where is a lagoon: the beach there is entirely composed of pumice-stone 4 or 5 feet deep, which has been carried across the sea from Ambrym opposite. While I was on Malekula there was a fissure eruption of this volcano, and numbers of fresh secondary cones were formed along the coast of Ambrym. There was no loss of life, but considerable destruction of property. During one of the coastal expeditions I and my boys were overtaken by darkness before we were halfway back. Since the tide was high we had to turn into the bush, where the boys collected numbers of a luminous fungus, the sticky caps of which were attached to themselves and the equipment to light us on our way.

From Unua I went next to Atchin, a small island a mile from the north-east coast, because the Seventh Day Adventist missionary living there is in charge of another mission station at Malua Bay on the north-west, from which the bush of the limestone terraces could be worked and also the hills of the interior. Here I had my first introduction to untamed Malekulans, for at a peaceful little lake on the mainland where I made almost daily excursions after aquatic insects, one morning I found a native keeping guard with a gun, because one of his relatives had been killed by a hillman the day before. I was obliged to send back my boy and work alone. I also took as guide for the whole of one day a native who was supposed to be mad and have fits of frenzy, during one of which he had murdered another boy. I took him ignorantly, but in so doing began to build up a reputation for being immune to evil spirits which stood me in good stead later.

Mr. and Mrs. Smith were extremely kind in helping me to carry out all my plans, and during my two months' stay on Atchin made two visits to Malua Bay expressly to give me the opportunity of collecting there. There is no regular boat service to that part of Malekula, but trading and recruiting schooners call there occasionally. All the interior of the north is owned by two cannibal tribes, known as the Big Nambas and the Small Nambas. The former is a very well-organized tribe with a paramount chief, and is still numerically strong; but the Small Nambas natives, owing to ancient feuds, are fast being wiped out by their stronger neighbours. The Malua river forms a natural boundary between the territory of the Big Nambas and Small Nambas tribes. At the mouth of the river, a few years ago, some Big Nambas natives murdered a recruiter who had kidnapped two boys belonging to the tribe; they had waited for their victim for twelve years, and would have taken away the corpse to be eaten, but the tide carried the boat containing it out to his schooner at anchor and his crew recovered it.

The mission converts at the time of my visit consisted chiefly of Small Nambas natives, but there were three men who had recently joined from the Big Nambas tribe, and two women belonging to outlawed villages of the same tribe. One collecting expedition was made in that direction, and, accompanied by Mrs. Smith and these two women, I visited their former homes. The first village is just below the ridge of Bartarramul hill, which is semicircular and

very conspicuous from any point of the open plateau. From the chief of this village I bought complete dresses of a man and a woman, with ornaments, and also some weapons. Among these was a club which had belonged to the chief's grandfather, who had killed five men with it; his father had killed three with the same club; but he would not tell me what his own quota had been. There was also a heavy wooden chopper which was formerly used for dividing up the victim at a cannibal feast. These two were made of *Casuarina*, the blade of the latter having been brought to a fine edge.

In the hills to the north of Bartarramul several streams rise, among them the river Lua which flows into the sea opposite Atchin. Aquatic insects collected on that occasion were of special interest. From the highest coral terrace I could see very plainly another plateau to the south-west, covered in dense bush, the rim forming a straight line against the sky. This is Big Nambas territory, and the altitude is given as 2000 feet on the chart. I wished especially to collect there, and endeavoured to get the three converts from that tribe to act as guides; they could not however be persuaded to accompany me anywhere beyond the river. Although I worked on that side of the river many days I searched in vain for a trail leading in the right direction. On one occasion when following the river, the three boys were unwilling to go farther because it was Big Nambas territory, and when I left them behind and went alone, the head-guide came after to implore me with tears not to go any farther as he was certain we would be attacked and eaten. While at that mission station I was informed by one of the natives that I need have no fear in penetrating any of the bush on Malekula. He assured me that I was known on most parts of the island and that a *tambu* had been set upon me, which signified that my person was sacred, and that I "had been given a name." I made careful inquiry of the same native, who was of an unusually intelligent type, what means I should adopt to ensure the safety of my boys, and was told that any one accompanying me into the bush would be safe as long as he was of my party. This surprising prohibition was of great service in my later work. I have reason to suppose that I had the reputation for being a "medicine woman," as has happened to other women in different parts of the world. In my own case it was probably owing to the fact that I carry a box of tubes of methylated spirit attached to my belt for preserving ants, and this was looked upon as magic medicine. I noticed constantly when entering a strange village that the natives would point out this box to one another as if they had heard about it.

A curious case of the native's control of his own vitality occurred at the mission station. Mrs. Smith one night received a message from the mission village asking for medicine for a boy with a bad headache. Mr. Smith was away and she came to me. I had only aspirin with me, and as it was unwise to send this without seeing the patient, we went up to the village and found a boy in a kind of seizure. He and some companions had gone to collect coconuts from trees growing on a deserted dancing-ground. Such fruit would be *tambu*, but since the village that owned the ground was broken up this would no longer apply; however, they were conscious that the trees had once been sacred. This particular boy saw a snake in the tree he climbed (no unusual sight, but on that occasion it took on a new significance), and he found a devil's face on a coconut. They straightway left everything and came back hastily to the village,

where the boy complained of a pain in his head, lay down in his hut, and became unconscious. He remained in this state for several days and then died.

At the end of the second visit to Malua Bay I returned on foot through Small Nambas country, joined the main stream of the river Lua near its source, and followed it down to the coast. I had intended to stop for a few days in Rarab, but unfortunately there was a feast and dance being held that very night, and as it was *tambu* for any strangers to remain in that district we were obliged to hurry on and encamp in the bush. One of the boys was lame and could scarcely walk during the latter part of the journey. We encamped on the river bank below a hill inhabited by natives who are bitter enemies of the Atchinese. The boys were extremely nervous of attack, but since darkness overtook us before we were beyond that territory nothing could be done but stay there until daylight. It is highly improbable that the hillmen knew of our presence, and if they had seen us they would have known also that there was a white woman of the party, but it was a member of this tribe which had recently killed the boy from Atchin. In early morning we continued our journey and reached the coast before noon. Only the upper part of the river presented any new features; there the vegetation was rather different, with fern-covered areas, with a greater variety of species, and *Melastoma* and other shrubs not occurring in the coastal region. Therefore the insects were more interesting and several species were new to my collection.

Having visited Santo and Banks Islands I returned to work on the western side of Malekula, where the Presbyterian mission kindly lent me an empty mission-house at Windua, South-West Bay. From there several expeditions were made inland in various directions, and along the coast to Lambubu. I was also fortunate in being able to return to the Big Nambas territory to collect on the high, bush-covered plateau.

The manager of Mr. Fysh's plantation on Santo, who was recruiting labour from Malekula, happened to put in at South-West Bay; he was then on his way to Tnmaru beach, and offered to take me there. I stipulated that I should be left there for five or six days and then called for, but in the end Mr. Newton arranged to go up to the village himself with two of his crew, if King Ringapat would give permission. Mr. Newton brought the news that the Big Nambas converts at the Malua Bay mission had been attacked by their own tribesmen, two men were killed and one escaped seriously wounded. He himself was in favour with Ringapat because he restored two native boys to their village punctually when their service was ended, and also because he had made the king a present of a large cattle-dog. No recruiter has ever dared to visit a bush-village before; as a general rule they do not even land on the beach but negotiate from a boat; but Mr. Newton was considered to belong to my party and my *tambu* extended to him, which was an additional safeguard.

Ringapat is king or paramount chief of the Big Nambas tribe: he is of patrilineal descent and comes of a long line of ancestors, and has only recently succeeded his father, Nikapat, a notorious old cannibal who made himself feared throughout the island. Nikapat had sixty wives; Ringapat at present has seventeen, but he is only twenty-eight years old. As a young boy he worked for a time on a plantation and can speak pidgin English and a little French. When my arrival had been announced in his village of Tnmaru,

which is about 3 miles from the coast, Ringapat came down to the beach to meet me, and having heard that I wanted to collect in his territory at once acceded to my request and invited me to stay in his village: he seemed quite pleased that I should wish to do so. He arrived on the beach with a numerous retinue of men armed with guns in addition to his own bodyguard, which includes one who acts as his aide-de-camp.

The bodyguard is composed of the king's half-brothers. All the boys of the royal family are brought up together, and when the heir succeeds his father, his half-brothers serve him, one being his constant companion and adviser. This seems a sound regulation, because by such means the king learns to know those who are to surround him personally as thoroughly as it is possible to know any human beings. Ringapat's aide-de-camp was named Loshai. A fowl had been brought down with them as a present, and this had to be boiled and cooked with a yam and duly eaten before we went up to Tnmaru. Ringapat himself carved the fowl when it was ready, hacking it to pieces with his large knife. The Big Nambas dress for a man consists only of a broad belt made of bark, with a large tassel—the *nambas*—in front, made of strips of a small *Pandanus* which is very common in the bush. Nose ornaments of stone or bone, earrings of coiled turtle-shell, and a bracelet of curved boar's tusk, complete the costume. The only things adopted by the bush natives from the white man are guns and cartridges, tobacco and pipes; all the rest of their simple requirements are to be found in the bush.

We took two and a half hours to reach the top of the plateau, climbing five terraces on the way; then we passed some flourishing and well-kept yam-gardens and eventually reached the village of Tnmaru. The village is enclosed with a double fence made of a fine bamboo which forms extensive thickets on the higher terraces. The fencing is very neat, and I saw no other like it in that group. It was fully 6 feet high, the canes put very close together and strengthened by transverse bundles bound together with creepers. One entered by a high stile where the canes were laid transversely to about 4 feet from the ground; then the second stile had to be climbed in the inner fence. The whole village was divided up into small plots, each family owning a hut in a small clearing surrounded by similar fences; narrow alleyways were thus formed between the plots. The huts are very large, with the roof slanting down to the ground at the back, this mode of building being peculiar to the Big Nambas tribe. The walls are thatched with wild cane, and the roof with leaves of areca-nut palm, which is found all over the islands in the forest. It is always easy to see at a glance whether a native village is in fear of enemies or not by the form of the huts. No native will take so much trouble to build thick walls unless he is afraid of a spear or a gun-barrel being thrust through them while he is asleep. The Big Nambas are continually fighting with their rival tribe the Small Nambas, but it would be practically impossible to penetrate the extremely thick walls of their huts even if the double barricade had been passed.

Ringapat's compound had two large huts full of his wives, and the children were playing about outside. There were seven children altogether, three boys and four girls. Leva, the heir, was then about eight years old. The youngest, a boy named Neddenvel, could just toddle; he alone of the children was never

shy of us from the very beginning, but was utterly fearless. The family name is *Pat*, and the eldest child inherits it. Of Ringapat's children the eldest was a girl called Witapat: Leva at his accession will become Leva-pat. Ringapat was very fond of his children and showed more affection for them than I have ever noticed in any Melanesian parent before: for these natives seem for the most part quite indifferent to their children, and this is particularly noticeable in the mothers.

The women took much longer to get accustomed to me than the children did, and it was only after some time that they would venture out of their huts in my presence. It was a very long time before they would remain if I made a movement; and even when they refrained from bolting through the doorway they would draw the grass-veil which they wear over the face to cover it. The dress of the Big Nambas women consists of a "grass" skirt and a long, narrow mat with a deep fringe. This is doubled twice to form the head-dress and hangs down the back almost to the ankles. When anything frightens or embarrasses a woman she will draw the fringe from each side to cover her face like a veil.

The bush-women have a form of obeisance which must be made whenever they pass the king. They bow low from the waist and cover the face with the veil. His own women never do this. There are many occasions when women from bush-villages have to enter the king's enclosure because they bring vegetables from the gardens. The royal wives also fetch vegetables, but apparently only from particular gardens which are not far from Tnmaru; the rest may be brought from some distance. If the king happened to be in his enclosure when these bush-women came in they would pass him as just described. By chance I discovered that the obeisance was also being made to me, for on two occasions when Ringapat was absent and I happened to be sitting in the enclosure, the bush-women saluted me as they passed. Ringapat had not told them to do so; but when he questioned his wives they informed him that it was an actual fact that the obeisance had been intended for me. I found that other women did the same. In all probability it was something to do with my reputation for being a medicine-woman. From what one can piece together from the scanty evidence of bush-devils—the *tamis* of south-west Malekula, the *iaramus* of Erromanga, and *natmus* of Tanna—I must have borne a flattering resemblance to the ideal bush-devil of all the tribes. If I chanced to meet a party of women on a bush-trail, as I often did while collecting near Tnmaru on the plateau, there was seldom any chance of coming near them. One would have a glimpse of them in the distance perhaps, or hear their voices; then the boys with me would call out to them some sort of warning, and when one reached the spot it would be to see all their bundles dropped near the trail, and waving grass or branches would be the only sign that a living being had passed through them.

Ringapat's women seemed happy and on very friendly terms with him. They were young and all looked healthy, but six of the seventeen are dead. As a general rule the women of those bush tribes have a miserable existence, being mere beasts of burden to the men who own them. A woman belongs to her father, and, if he should die, to an uncle or to her eldest brother. She has to do all the drudgery, and he has the right to sell her for so many pigs to her

prospective husband. After marriage she becomes the property of her husband, who may treat her as he pleases without interference; but should she run away from him the whole village will turn out to hunt her with dogs; and should she be caught the punishment may be that red-hot stones are tied under her knees. Women are sometimes crippled for life by having the muscles burnt in this fashion.

The days were spent in collecting, but in the evening I sat on a board outside Ringapat's hut, and sorted out specimens into the drying-trays and papered them or wrote out notes. Then if Ringapat had returned from hunting pigeon with the recruiter, he or I would ask questions, for he was very curious to know something about England, much more than is usually the case among these natives. The recruiter spoke and understood pidgin English very well, and gave me much information which I should not have gleaned otherwise. Ringapat explained many points about cannibalism which gave me an entirely new view of it. He is personally exerting himself to put a stop to the terrible custom, and this is probably the reason why he was willing to discuss it; he has already taken the first step in that direction.

One of the most important ceremonies of that tribe is that of the initiation of the boys. There is no particular age, but when a sufficient number of boys are considered eligible, the ceremony takes place; therefore it is held every few years. After certain rites have been performed the boys are accepted as full members of the tribe; they associate with the men, and sleep henceforth in the club-house, the *gamal*, until they marry and have houses of their own. (The *gamal* is a sacred building containing family relics.) It has always been the custom that a man should be killed and eaten on this occasion; and while staying at the mission at Malua Bay the year before, the mission boys had been very uneasy because they heard the gongs being beaten in the Big Nambas villages, and knew that the time of this feast was near at hand. But Ringapat has made a new regulation and substituted a pig for the human sacrifice. This has been done on other groups and on other parts of the island in bygone days, and Ringapat doubtless adopted the same measure because he had heard of it.

He told me however that he would never really wipe out cannibalism until certain of his old chiefs were dead, who refused to give it up. According to him there is a certain type of depraved cannibals who are despised by all respectable members of the tribe; these are the men who eat human flesh because they like the flavour. I gathered that these old chiefs were of this type; and have a suspicion that Nikapat was also, for it is rumoured that he used to indulge in the ghastly habit of eating babies. But Ringapat did not like speaking of his father. The motive for cannibalism among that tribe is fear of the spirit of the murdered man, for this will walk the earth and bring evil upon his murderer or the villagers or even the tribe. But if the corpse be divided among several people and eaten, then the spirit ceases to exist: there seemed to be no idea of some good quality of the dead man, such as courage, entering those who ate his flesh. Relatives are not eaten, but enemies must be thus destroyed; and the more powerful the man in life, the more haste is shown in holding a cannibal feast to dissipate the spirit at once.

In Tnmaru I lodged in the royal yam-shed, while Mr. Newton and his two

boys slept in the *gamal* with the unmarried men of the village. There were several *gamals* in the village, but one belonged particularly to Ringapat's family. The gable was ornamented with a conventional head carved in tree-fern. The first evening Ringapat held a meeting there which Mr. Newton and his two boys were asked to attend. The men of the village assembled and our presence was explained to them and *kava* was drunk ceremoniously. The *gamal* contains the skeletons of Ringapat's ancestors in a direct line, the skulls placed on a platform, the leg and arm-bones in a heap on one side, and the bark belts hung up on the wall. No woman is allowed in the *gamal*, but I was permitted to get over the stile into the enclosure to sketch the gable ornament.

Outside the *gamal* there usually grows a species of *Polyscias* whose leaves are used in the operation of extracting the woman's two front teeth, which takes place at her marriage. The leaves are doubled up and the broken edges rubbed on the gums before extraction, which is said to numb the gums so that no pain is felt.

The evening before I left Tnmaru, Ringapat announced that he had a message for King George, and wished me to take it. When I explained that I could not give it by word of mouth, but would write it down on paper and have this forwarded to the King's secretary, he was very doubtful; and I had to impersonate severally many officials, each receiving the letter and passing it on to the next until it reached His Majesty, before he realized that I was not treating his request lightly. The message was given me in pidgin English, and was repeated three times before I wrote it down. It was: Ringapat, King of the Big Nambas, wishes King George to know that he will never eat man's flesh, white man or black boy; that he will never kill man, either white man or black boy; and that he will be good to all white men so long as they are good to his boys and do not steal them.

I understood that this was a personal vow of Ringapat's, for he had emphasized that he could not reform some of his chiefs, and while I was in that village there had been a meeting of the chiefs to discuss reprisals on another village, Tinnamat, because three Tnmaru boys had been killed in a skirmish over fishing rights. This could only end in a cannibal feast. Ringapat's message had been prepared for some time, but he wished to send a present with it, and the choice of this was serious. Finally he selected some black-and-white beads made of shells and coconut, which he had himself worn for many years, and a carved spear which had been in his family for generations. It was formerly used in fighting. His Majesty was graciously pleased to accept the message and the present. When the spear reached the Natural History Museum Dr. Regan had the poisoned point cleaned before it was forwarded to its destination; the reaction to the tests suggested that it was strychnine. *Strychnos* has been recorded from that group, but from which island the specimens were obtained is not known.

Ringapat warned me that the poison on the tip was very strong, and that if it only scratched me I should die. I received the information with due seriousness, but did not suppose that it was actually poisoned. The poisons employed by natives of Malekula have long been renowned in the group, and natives have been known to come from long distances on purpose to obtain

them. But although both French and English doctors have repeatedly tested the so-called poisons they have always proved innocuous. Of course if a native thinks he has been poisoned he cannot be persuaded otherwise; therefore, whatever the weapons may be dipped into, they will have the same effect as though they were poisoned. If I had suspected that any real poison had really been employed I might have obtained information concerning the symptoms following a wound made by this spear.

The sorcerer of that village was the one person who was not introduced to me, but I believe it was a brother of Nikapat's who was constantly to be seen with Ringapat. The sorcerer has the highest power next to the king, whose person is *tambu* and therefore cannot be affected even by sorcery. The sorcerer enforces the laws of the tribe by very simple means. Any one convicted of a crime—breaking a *tambu*—is brought before a council of chiefs and judgment passed on him and the sorcerer delivers the sentence: forfeit of land or pigs, banishment, or death; if the last, the sorcerer tells him that in so many moons (months) he will die; and at the end of that time the man dies, apparently through self-suggestion. The natives of that tribe who had joined the mission at Malua Bay had been condemned by their fellow-tribesmen for breaking a law, but had escaped punishment by running away. Their murder was therefore merely to enforce the law of the tribe. The organization of the Big Nambas tribe is of unusual interest, and it is greatly to be regretted that no anthropologist has yet studied it.

On leaving Tnmaru I returned to the coast in a south-westerly direction expressly to collect in the forest of that district. The insects were the same as those of the hills near South-West Bay. We passed five large bush-villages, two of which were at war with Ringapat's village, and finally met the launch at the beach near Elephant Point. At the first village, named Varass, another guide had to be procured. The inhabitants seemed very suspicious and no women or children appeared. Possibly Ringapat foresaw that there might be some difficulty, for his aide-de-camp, Loshai, arrived while negotiations were proceeding, and after his advent all things proceeded smoothly. Before this however Mr. Newton gave offence by producing two coconut shells used for drinking kava, which he had bought. Apparently the boy had had no right to sell them. I also offended by examining a rat-skin hung up in a tree outside the *gamal*, for it happened to be *tambu*. Later I learned that all white people were hated by those villagers because two of their boys had been taken by a French recruiter without the sanction of their chief, and one had died. The French Government had been informed, and a bullock presented to the village in reparation for the death, but the feeling was still bitter.

A guide was procured and we were warned to pass the next two villages in the district of Ammoch as silently as possible lest the inhabitants should try to attack us. All these villages resembled Tnmaru. About midday we were skirting the bamboo fence of another village, walking as I should imagine without sound, but the inhabitants taking their siesta inside the huts heard us and came out to investigate. They were very friendly, and some accompanied us farther. Two men from that village had worked in plantations; about half a dozen had seen white men on the trading schooners which occasionally

Present coral reef, Malekula

Elevated coral terraces

Marble limestone rocks on Mount Villikus

Yam-shed at Vinnibubu

stop at the nearest beach. None of the rest had ever seen a white man. It is curious when one remembers that there have been white settlers in the New Hebrides for about a hundred and twenty years. It is testimony to the incuriousness of the natives as well as their unhappy experiences at the hands of white men.

Near the end of my time on Malekula some more collecting had to be carried out in the hilly country of the interior. I therefore planned to climb Mount Penot, the highest point (2925 feet) in the centre of the island, and collect in that neighbourhood. There is a central peak visible from the sea on the west, and this had always been referred to by residents as Mount Penot. I did not find out until I had climbed it that this is another mountain, Mount Penot not being visible from that side of the island. The mountain is named Villikus, and belongs to a very primitive tribe. My first efforts to obtain guides and carriers were unsuccessful, but at length five boys offered to accompany me to the first village, where we could pick up another boy to guide us to the next, and so on. The mountain was about 9 miles from Windua as the crow flies, but it took five days to reach it and return.

The first night was spent at Vinnibubu, the second village on the very devious route we were obliged to follow. This village was of the most wretched description, a collection of very poor huts in a small dell of liquid clay, for the weather was very wet. A yam-shed was allotted to me by the chief. My tarpaulin fly had to be fastened to it inside the roof, which leaked badly; the boys slept in one of the huts of the village. The chief provided as guide his small son of six years. I was at first very doubtful of his ability, but learned that he alone knew the bush-trails, and was friendly with all the bush natives round about, because as soon as he could walk he would go off by himself into the bush and follow natives to their homes and learn their various dialects, only returning home when this life bored him. He had been re-named Samshim (Samson) by a boy of Vinnibubu who had joined the Presbyterian mission at Windua, because the child had shown a remarkable strength for his age, which reminded the mission boy of the Old Testament hero. I also had evidence of this, for Samshim on one occasion carried four hands of bananas unaided for some miles, a load which I could scarcely lift from the ground. He also killed a pig unaided.

The second afternoon we reached a spur of Mount Villikus on which were two solitary huts above a deserted village, Vellumbiye. The bushmen interviewed by Samshim gave permission for me to lodge in a yam-shed belonging to them, of which we took instant possession, for we arrived in a violent thunderstorm and fires had to be lighted in the shed to dry the equipment and stores. The two bushmen partook of a meal with my boys and informed them that they were the only survivors of some epidemic, probably influenza, which had wiped out the entire population of the village below. There were sixteen huts, which signified sixteen families had been living there; and these all died in a few weeks. The bushmen also warned my boys that it was not safe for me to sleep in that yam-shed on account of all the spirits of these people who haunted that spot. But this interesting information was not passed on to me: I believe that they were too frightened to mention bush-devils lest some of them should be eavesdropping in their vicinity.

The boys retired to sleep in one of the bushmen's huts, but a couple of hours later hurried back to me in a state of terror to ask whether they might sleep in the yam-shed. I could not extract from them what had occurred, but allowed three to sleep below and two on the platform, partitioned off with the tarpaulin. This made a close atmosphere; the fires had to be rekindled, and the smoke from damp logs became so intolerable that I slipped off the platform, and taking my rug, groped my way into the bush and slept among the roots of a tree until daylight. It was only after quitting that neighbourhood when we were on the return journey that the boys volunteered the reason for their behaviour. They had discovered a corpse in the bushman's hut; it being the custom of that tribe to keep their relatives after death until the skeleton was clean, when the skull would be preserved and probably some bones retained for spear-heads, while the rest is buried. It was not the unpleasant atmosphere which disconcerted my boys but the knowledge that the man's spirit was somewhere near and might prove hostile to members of a strange tribe. When I quitted the yam-shed, the boys talked for so long that I had to call to them to go to sleep; they told me afterwards that each had been urging the rest that some one ought to warn me of the danger in sleeping in the bush with so many bush-devils at liberty. But not one of them had the courage to leave the shed.

Next morning I was told that I had permission to go on to the mountain, but only to stay one night. My request for yam or taro for the boys was evaded, although biscuits and tobacco were offered in exchange; and at the next village, Liyarrup, where I spoke to some of the men through my young interpreter, I saw no women or children either then or on the return journey. I was asked in that village to see an old man who was sick; finding that he was feverish, I dosed him with quinine and aspirin and left him some tea and biscuits, as he had had no food for days. A trail was cut by the bushmen who accompanied us from that village, straight up the side of the mountain, and we reached a ridge that led to the summit in about three hours. The slope was composed of the rich, black soil of the same appearance as all the hills of the interior which I have seen, with red clay in patches, and at intervals rounded stones of various sizes. One specimen which I took back with me proved to be water-worn coral limestone. On the top of the ridge the bushmen turned aside to show me a natural circle of small limestone rocks, in such symmetrical order that I at first concluded that they had been carried there by the natives, some being slabs that looked as if they were squared by human agency. The bushmen call them the seven piccaninnies of Villikus, and have named them collectively Levitmos.

The top of the conical peak was an easy climb from there: it is flat and circular, and about 100 yards across. The vegetation does not differ from that of the lower forest except that it is more sparse. There were no large trees, but many specimens of a fig *Ficus copiosa*, very common all over the island, and young *Banians* and young *Inocarpus edulis;* I was guilty for the only time in my life of carving my initials on a tree with the date. At a lower level on the opposite slope we suddenly came upon entirely different conditions, for the whole of that side was made up of massive marble limestone crags, towering to a great height, with the bush growing between them; and large trees forcing their roots among them and tending to split off fragments, while the ground was

strewn with boulders. Here we encamped, and the bushmen left us and returned to Liyarrup. They first however pointed out a curious natural basin under a rock, shaped like a stoup, which held the water that percolated the limestone. My boys were told that if Mount Villikus approved of me he would supply me with water, and they were gratified to have this practical testimony of his favour, and still more so on discovering that there was precisely enough to fill the largest billy-can, which provided a mug of tea for each of the party. The bushmen also showed them another spot where water could be obtained; this however was a *tambu* place which no woman was supposed to look at. By standing out on a slab of rock after a few branches had been cut away, one could get an extensive view right across Malekula to the east coast. To the north-east the hills behind Pangkumu Bay were to be recognized; all the centre on that side is lowlying marshy land of which the bushmen had told me: low bush starred with tree-ferns. North-north-east was a rounded peak, which I erroneously took to be Sharp Peak, because I believed that we were then standing on Penot. This was evidently Mount Penot that I was looking at, whereas I concluded that Mount Penot was not in the right position on the Admiralty chart of Malekula. The boys built themselves a hut of branches with my tarpaulin sheet as a roof, while I caught insects which came to the moth-sheet. There was only one slight shower and insects were coming in numbers until four a.m. In the morning the boys fetched the billy-can from where it had been left the night before; again it was filled exactly to the brim, and I was told that there was not a drop more water on the whole mountain. The boys were so excited that they insisted upon my accompanying them to look at the *tambu* place in spite of the prohibition. By crawling out on to a jutting rock I was shown a group of stalactites on the underside of a rock above. Water had dripped from the largest of them in the night, but by a strange coincidence the supply had again been exactly sufficient for our needs.

We returned to Vellumbiye in the afternoon in time to do some collecting in that neighbourhood before dark; then my hammock was slung among some trees, and the boys occupied the yam-shed. When we reached the yam-shed I found yams, taro, and bananas more than sufficient for the boys; they were a gift from relatives of the sick man. On passing through Liyarrup we were informed that he was much better. It was related to him how we had been given water on the mountain, which evoked the solemn pronouncement that Villikus had been good to the white missus, but now the big mountain intended that she should go away as he had no more water for her. The bushmen cannot be said to have been unfriendly, but they were probably relieved at my departure; and the sight of the empty huts, the result of what my boys called "sickness belong white man," was sufficient to excuse them. I should have stayed longer in that neighbourhood, but the boys were so nervous and so anxious to leave that the work of collecting had to be hurried through as much as possible, and we returned two days later to South-West Bay.

This was my last expedition into the bush of Malekula, except for crossing the island for the fourth time, when, starting from Lambubu, I passed over the low divide through two villages which were at war, to catch a steamer for Sydney at Bushman Bay.

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: It might sound somewhat paradoxical to say that while it is remarkable that between such important places as Fiji and Australia there lies a group of islands, the New Hebrides, that is very little known, it is also remarkable that those islands have been visited by a large number of people. Malekula, of which we are to hear to-night from Miss Cheesman, was discovered by De Quiros in 1606. Subsequently it was visited by Captain Cook, who named some of the places there. But I will, if I may, reserve such remarks as I have to make about the place itself until after the lecture. Miss Cheesman, our lecturer, is an entomologist, and in pursuit of her profession she has travelled widely in the South Seas, the Galapagos, and many other places. I know it is not as a rule entirely complimentary to refer to anybody as a personality by mentioning their relations, although in this hall, as some will remember, Sir Hugh Bell said that he was proud to be known as the husband of Florence Bell until he became better known still later as Gertrude's father. But Miss Cheesman may be assured that she is none the less welcome here for being the sister of Major Cheesman, who has so often contributed to our knowledge both of Abyssinia and of Arabia. Miss Cheesman has spent the better part of two years in Malekula and had admirable opportunities for observing the place and its inhabitants, which she will describe to us in a lecture which I now invite her to begin.

Miss Cheesman then read the paper printed above, and a discussion followed.

The PRESIDENT: Dr. Ivens of the Melanesian Mission is with us. He has spent twenty years or more in those islands. I will ask him to address us.

Dr. IVENS: For a man to have done what Miss Cheesman has done would have been remarkable. It is amazing that a woman should have gone to these wild places to do what she has done and then think nothing of it.

There are one or two remarks I should like to make about Malekula, that very wonderful island. I should very much like to know the derivation of its name. I hardly doubt that *Male* means place, but what *kula* means I cannot say. Malekula reminds me of an island on which I lived in the Solomons which bears almost the same four initial letters, Mala. Both of them are patrilineal amongst a set of matrilineal neighbours. I am not sure about the people of Santo, the next island to Malekula, whether they are patrilineal or not. I rather think not. The Nambas are evidently very fine people. A people who in fifty years or more have not got into touch with white civilization are a people much to be congratulated. For, alas, Miss Cheesman has said, and one knows, that two things arrive with white civilization: one is given unasked and the other is definitely brought in. The first is influenza, which is the curse of the Pacific; the other—I do not know whether it is a worse curse, but we in the Solomon Islands have known what it is to live amongst a set of people who are all armed as the people of Malekula are still evidently armed to-day with rifles. In our part the British Government disarmed the people, but the Condominium Government has not yet been able to disarm the people, and, as far as one knows, there is still a sale of arms in the New Hebrides. As to cannibalism, one would like to think there was another reason for it beside mere hunger. I am of the opinion of Dr. Fison, that cannibalism in the Pacific is caused by the people getting fed up with eating vegetables. No *post facto* rationalization is really necessary to my mind, such as that of eating one's enemies or disposing of the power of their ghosts. It is simply that the people get tired of eating vegetables. If there are no rats, grubs, or lizards to eat, well, human flesh is a very acceptable thing. I am quite convinced that that

is the reason at the bottom of cannibalism in the Solomon Islands, as Dr. Fison said it was in Fiji, which is the *locus classicus* for cannibalism in the Pacific.

May I say, Miss Cheesman, that I think the word *pat* at the end of the names of the chiefs means "Head." It may also mean "stone," as you say, in which case the Great Nambas people may possibly be connected with the stone cult on Malekula. I had the pleasure of reading your manuscript and your description of the stone circle on the top of Mount Villikus, which I think is artificial. Mr. Layard has shown, and Dr. Rivers before him, that there are stone circles and dolmans and standing stones on Malekula; I am not sure whether they are also on Santo. I think Miss Cheesman's "Seven Sisters" an artificial circle. The word *Levit* definitely means seven, and the *tmas* or *tmos*—I think Miss Cheesman dropped a *t*—means ghost or spirit.

The PRESIDENT: Before I add my congratulations and the thanks of the Society to Miss Cheesman for her most interesting lecture there are one or two points I would like to mention.

De Quiros discovered Malekula. Then came a long gap. Captain Cook landed there in July 1774, and he speaks of the islanders as in general the most ugly and ill-proportioned people he ever met. Except for some show of force on both sides, both at Port Sandwich and South-west Bay, first on the eastern and then on the western side, there was no real disturbance. It is interesting to find in Captain Cook's 'Voyages' a landscape drawn by Hodges, who was Cook's landscape painter, of Malekula and Sandwich Bay. Sandwich was the name of the First Lord of the Admiralty at the time, and there are other places named after him in different parts of the world.

It may be of interest to the Fellows of the Society—it certainly is to me personally—to have some description of a visit which was paid fifty-seven years ago to Malekula by my father a fortnight before he received those wounds which caused his death a week later. My father was very much interested in all the various things which he found in little-known places. He says in his journal, after landing in Port Sandwich: "On coming off, Messer [he was the doctor] told us that, while sketching, a boy stole up to him, measured his nose with a straw, broke off the straw, and went away gently and thoughtfully"; and he goes on to say, "This and other things irresistibly call to one's mind that they are speaking of us as we of them. We are measuring their facial angles, writing down their language"—those interested in the latter will find at the end of my father's Life a considerable vocabulary of the different languages. It is interesting to find that not only is the language very different in adjoining islands, but quite different in the different parts of Malekula itself. Dr. Ivens told me before the lecture that there are no less than ten languages in Malekula. To return to my father's description—"writing down their language, pacing their houses, they measuring our noses. We talk of their savage treachery, but I think these are not altogether an unamiable people."

I have two slides which are of some interest, the first the picture of a native painted, not tattooed, as they were on their gala days or in honour of those who landed from the *Pearl*, my father's flagship. He described them as being indescribably filthy: "the dress and ornaments of the people appear to be like those of the Ambrym people. Among the things which we collected were figures of ancestors," and Miss Cheesman has brought here the figure of an ancestor which many will examine with interest. It is almost Futurist in its simplicity.

Then my father goes on to remark that after they had landed they were followed by a youth who mimicked everything they said with most surprising accuracy, and he mentions what is of very great interest to us in this Society, namely, the accuracy of Captain Cook: "Everything he did and wrote down is as remarkable

as ever. It never fails." My father next went across to South-west Bay, and here is a picture, drawn by himself, of what is called a chief or dead house, whether a house where bodies were put before burial or whether one where they are prepared for some cannibalistic feast does not appear certain. "It is remarkable that just in proportion to the amount of people which have been taken away as labourers by what are called the recruiters, so they are disinclined to deal with Europeans. Where white men are less known the people are most friendly." It is therefore with great satisfaction that one can turn to the latest edition of the Sailing Directions and read there of the natives that "they are divided into two people, the salt-water men and the bushmen. The salt-water men have the reputation of being very treacherous, but of late years more frequent intercourse with white men and the presence of resident missionaries have done much to modify their character. The bushmen live entirely among the hills and small villages, and are seldom seen."

Then Miss Grimshaw was in Malekula in 1906, and a very good description is to be found in her book 'From Fiji to the Cannibal Islands.' Sixty years ago the estimated population of the New Hebrides was about 70,000, of which 10,000 lived on Malekula.

Miss Cheesman has shown us what an immense amount of interest, and new interest, can be found in a small island. I can assure her that she has given us a most interesting hour. I can only emphasize what Dr. Ivens has spoken of as the very great courage and persistence which she has shown in her investigations. I ask you, Miss Cheesman, to accept the thanks of the Society both for the work you have done and for the way in which you have described it to us to-night.

EXPLORATION IN TIERRA DEL FUEGO AND THE FUEGIAN ARCHIPELAGO: *A paper read at the Evening Meeting of the Society on 5 December 1932, by*

COLONEL CHARLES WELLINGTON FURLONG

FEW sections of the globe are less generally known or intrigue the imagination more than the cold Land of Fire. Since that early spring, over four hundred years ago, when Magellan first navigated the Strait which bears his name; since Jules Verne guided his *Nautilus* through the labyrinthine depths about Cape Horn, and Cook and Fitzroy charted and named many of its neighbouring hidden channels, Tierra del Fuego and its contiguous maze of islands have remained, comparatively speaking, a little-known region, and to no small extent are so to-day.

For over four centuries white men have passed through the Strait of Magellan and for over three hundred years have rounded the Horn. Yet those passing through the gale-swept Strait rarely landed on its shores, and until towards the end of the nineteenth century never penetrated the interior, while those rounding the stormy regions of the Horn often did so without getting a glimpse of the land. The Strait of Magellan, because of its terrific winds, strong currents, narrow passages, and scant anchorages, has always been an impracticable passage-way for sailing ships. The outer route of rounding the Horn, even with its terrific gales, made the open sea preferable to sailors. Many of these vessels, attempting to cut through the Strait Le Maire, because of storm, were wrecked on the outlying sub-Antarctic coast of Fuegia, which I define as the entire archipelago lying south of the Strait of Magellan, from lat. 52° 28′ S. to 55° 58′ S., and between long. 63° 43′ W. and long. 74′ 50° W. The flotsam and jetsam of these wrecks cast up on the shores of Fuegia proved an important economic factor to the Fuegians. Steam navigation diverted round-the-Horn traffic through the Strait of Magellan, after which one old Fuegian lamented that "nowadays there are no more wrecks." Then came the Panama Canal, which, through diverting the greater portion of navigation from the Strait northward, has again tended to increase the isolation of the Magellan Territory. Therefore it is not surprising that this great territory, lying between the Strait and the Horn, and comprising about 30,500 square miles, has remained such a *terra incognita*.

Not only is there a considerable portion of the interior of Fuegia still to be explored, particularly the south-western and extreme south-eastern part of Tierra del Fuego and a considerable portion of the interior of its other islands, but some hundreds of miles of the intricate coast-line of its hidden inlets, bays, and coves remain to be either explored or accurately charted. Sarmiento (7670 feet), its most noted and highest mountain, still remains unconquered. The only effort to make the hazardous ascent of Sarmiento that I know of was by that distinguished Fellow of our Society, Lord Conway, who in 1898 reached an altitude of over 4000 feet before he was driven back by storm, which is the great obstacle to its ascent; in fact, it is storm, more than any other factor, which, enshrouding these regions, has tended to isolate them from the rest of the world.

With the exception of Antarctica, Fuegia, about the size of Scotland, belongs

Colonel Furlong's routes through the Fuegian Archipelago

to the most southerly continental land. It is a vast archipelago, the islands of which are the mountain tops of the southernmost Andes, and into whose valley-ways have flowed the icy brine of the southern oceans, forming an almost inconceivable maze of channels. Except on the ocean-exposed and most precipitous coasts, the tree-line, at about 1000 feet, defines the elevation of the Fuegian forests. These selvedge the island sides in a dark green band, suggestive of a tidal mark of some forgotten age. Just above this in cloud and storm eternal snows crown the main ranges.

Tierra del Fuego, triangular in shape, occupies about 18,920 square miles, or well over two-thirds of the land area of the Fuegian archipelago. Besides five other large islands, averaging 1245 square miles each, the archipelago comprises thousands of smaller ones. Many of the islets are barren rocks, and the storm-exposed south-western outer coasts, as well as the precipitous coasts in the inland channels, are naked rock of granite or greenstone; but Fuegia, throughout the greater part of its mountainous area, is clothed with a sub-Antarctic jungle. With the exception of the Sierra Balmaceda and the Sierra Carmen Silva, its north-eastern area is composed of low, undulating plains, in places boggy, but for the most part covered with a bunch grass similar to the festuca grass of the Scottish moors. This region is an extension of the Patagonian pampas, and was undoubtedly connected with the same before the Strait was formed.

The south-west storms, sweeping up from the Antarctic in an eternal battle between land and water, hurl their terrific seas with almost unabated fury against these rock-bound coasts, terminating in Cape Horn itself, which stands a grim outpost of these nethermost parts of the world. When these prevailing south-west winds, cold and moisture-laden, meet the land, a rapid condensation occurs, with its consequent precipitation throughout the entire length of the Patagonian and Fuegian archipelago. Then these winds, released of much of their moisture, drop over the northerly and easterly sides of the Andean ranges, and sweep with terrific force in lighter, drier airs, called *pamperos*, across the pampas to the Atlantic. Consequently we have a distinct contrast of climate between the drenched, mountainous western regions and the low, drier pampas to the east. In the southern regions, particularly in the south-eastern half of Tierra del Fuego, there is a considerable variety of weather. For instance, the small exposed Isla de los Estados group on the extreme east of Tierra del Fuego has three times as great a precipitation as the protected bay of Ushuaia, midway on the south coast of Tierra del Fuego, where an eleven-year record shows an average rainfall of 21·5 inches. However as one follows northward from this coast on into Patagonia, the Andean *cordilleras* rise higher, and the aforementioned contrasts of climate become greater. One early missionary, who kept a meteorological record, noted one year "300 days of rain and storm—the other 65 not pleasant." It is a land in which wheat and other grains will not ripen, owing not so much to the low temperatures in winter as the lack of high temperatures in the short summers. The highest monthly mean at Ushuaia in 1910 was 10° C.

The objective of my expedition[1] to these regions was primarily to study the

[1] These expeditions were carried out in 1907–08, with a second journey to these regions in 1910, and another to Argentina and Chile in 1926. Owing however to the War and

southernmost inhabitants of the world against the background of their environment, to explore in the Fuegian archipelago, and more particularly to penetrate its largest island, Tierra del Fuego. Leaving New York on the tramp steamer *Celia*, I made an 8000-mile run south, with one stop at Montevideo for coal, and dropped anchor off Punta Arenas, now named Magallanes, the southernmost city of the world, where I disembarked. By good fortune, the Argentine training ship *Presidente Sarmiento* arrived shortly afterwards on her annual cruise to Ushuaia, the isolated Argentine penal colony in Beagle Channel, on the south coast of Tierra del Fuego. Through the courtesy of her commander, Captain Moneta, I continued south on board this beautiful frigate. After a hazardous voyage through fog, rain, and gales of snow, rolling round Brecknock Peninsula and nearly coming to grief in Belgrano Pass, we dropped anchor in Bahia Ushuaia, opposite the world's southernmost town. Above this little settlement the coastal range rose dark and abrupt, its upper snow reaches tinged with delicate rose by the cold southern sunset, and silhouetted against the ominous slatey blue of the clouds beyond. The skyline of this magnificent bay is accented by the graceful, needle-like peak of Mount Olivaia.

Aside from a coal-hulk, the only other craft in the harbour was the *Garibaldi*, a 35-foot cutter, owned by an Austrian trader and smuggler. This I chartered. After cruising eastward down Beagle Channel to Remolino (Whirlwind), the estancia of the Lawrences,[1] where I left my horse gear, I returned to Ushuaia with a cargo of one hundred sheep on the little craft. Here we got rid of the sheep, headed south through Murray Narrows and dropped anchor off Wulaia, an abandoned Yahgan village, where some years before there had been a massacre by Yahgans of members of the crew of the small schooner *Allen Gardner*. Near some kitchen middens and a freshwater stream I found the grave. The inscription had long since gone. I securely spiked a short piece of plank, found aboard the *Garibaldi*, at the head of what was left of the post, on which I painted the following inscription: "Here once lay the remains of the victims of the *Allen Gardner* massacre."

I eventually disembarked at a Yahgan camp at Rio Douglas on Navarin Island. The skipper, after trading a goodly amount of *wachiki* (aquadiente) with the Yahgans for nutria skins, then left me with a lot of drunken, fighting Amerinds[2] and sailed away. The camp lay up a narrow inlet into which flowed a small river. This I explored with Yahgans in canoes; also the shores of Navarin and Hoste Islands to the south. Later I found near the settlement a half-waterlogged river-boat, part of the cargo of a bygone wreck. After caulking the seams, repairing the tiller-head, making a new tiller, and rigging a small

subsequent expeditions in other parts of South America and Africa, the working up of my records of the Fuegian and Patagonian expeditions has been delayed, and save for a few short preliminary reports they have not been published.

[1] Martin, Fred, and Bert Lawrence, sons of an early missionary, had taken up sheep ranching on a narrow strip of open coast here at the foot of the Andes. To these three brothers, particularly the first, I am greatly indebted for hospitality and information relating to the Yahgans. Martin and Fred Lawrence are better acquainted with Yahgan life than any one else now living.

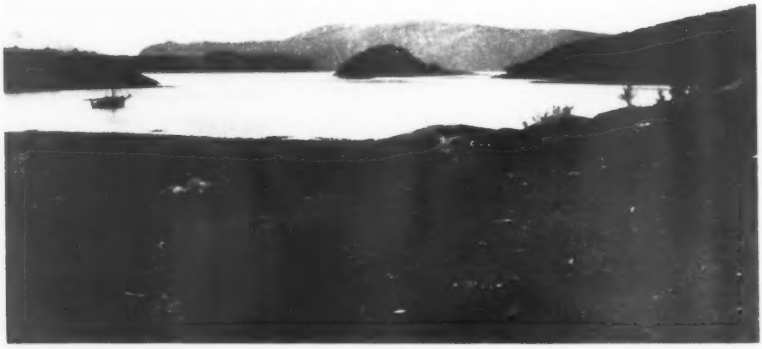
[2] To avoid confusing the autochthonus inhabitants of the western hemisphere and those of India by the use of the word Indian, the word Amerind (derived from American Indian) has been adopted by some ethnologists.

Cape Froward from the west: the southernmost point of the South American continent

Mount Sarmiento from Magdalen Channel

Looking south down Magdalen Sound

Looking north-west across Beagle Channel to Ushuaia Bay and Martial Mountains



"Garibaldi" anchored at Wulaia: Button Island in middle distance

Sub-Antarctic Beeches

sail patched with old canvas and burlap, I set out, with four Yahgans, for the Wollastons and Cape Horn. But the gales which swept across the Nassau Gulf along with the williwaws forced abandonment of this objective in such an ill-suited craft. Returning northward, we crossed Ponsonby Sound through Murray Narrows to Beagle Channel, stopping at other Yahgan settlements at Luaia, Laui, and elsewhere, making my base at Remolino.

Perhaps no people in the world have been more directly affected or limited by their environment than this Amerindian tribe, the Yahgans, and their immediate neighbours, not excepting their northernmost prototype, the Eskimo, whose life and culture in many respects parallel those of the Yahgan. In fact there seems to be little reason to doubt that these southernmost and northernmost people of the world, the Yahgan and the Eskimo respectively, are of the same ethnic stock, and that both are ethnically identified with the Amerindian race, which extends the length and breadth of the western hemisphere; also that the Amerindian race is of Mongolian stock, whose ancestors crossed by canoe from Asia to North America. This migration was, I believe, not across Bering Strait itself, as might be supposed, but from the easterly tip of what is now St. Lawrence Island, considerably south of the Strait, thus enabling them to avoid getting caught by the swift current of the Strait and to reach the American mainland, instead of being swept north through the Strait into the Arctic.

This need not exclude the theory that there may be certain other smaller, intrusive ethnic elements which have reached the west coast of South America from certain islands of the Pacific. The geographical position and character of the Yahgan's habitat has been primarily responsible for his isolation from the rest of mankind, but the factors of climate and elevation have not only had a very direct and marked effect on his character and life, but have caused perhaps the greatest tribal group and family segregation of any people within so small an area. This scattering in search of food bred in him an inherent independence. Living in constant storm inured the Yahgan's naked body to a marked degree to the penetrating cold and wetness; scarcity of food accustomed him to abstinence and endurance; an almost total absence of vegetable food habituated him to a nitrogenous diet, while meeting with constant dangers of land, sea, and the elements developed in him a stoical courage. Consequently the Yahgans are a people without chiefs, gods, or any form of worship. Before the coming of the white man they were without tobacco, or any form of intoxicating drink, and, save for an otter-skin covering over the shoulders, were without clothes. They are a stunted, big-headed, short-legged, uncouth type, with a mop of long black hair, trimmed at the eyebrows so as not to interfere with their vision. The men, from some twenty measurements I obtained, have an average height of about 5 feet 5 inches. In his dug-out canoe, in which a fire is usually kept burning, with his wife or wives and scant brood, always searching for food, the Yahgan skirts the more or less protected bays and leas of the Fuegian islands, on the coastal edges of which he dwells.

Incredible as it may seem, although these southernmost people of the world some sixty years ago numbered at least 2500, to-day there are only about fifty Yahgans left. The cause is not far to seek. Although this primitive type of man was able not only to withstand for centuries every challenge of warring

nature in these inhospitable latitudes but also to thrive, yet a short three-score years of contact with civilization caused him to wither under its blight. Of all the effects of civilization on primitive peoples none seems to be more fatal than measles, which in one epidemic more than decimated this tribe. Stefannson, the Arctic explorer, told me that one group of Eskimos were also decimated through the same cause.

Next to measles, drowning takes the largest toll. In some of these channels, particularly in such places as certain parts of the western end of Beagle Channel and Northwest Arm, the coasts rise in sheer walls of rock, offering no possible haven or even beaching-place in storm or sudden gales for the Yahgan's frail canoe; while open reaches, such as Ponsonby Sound and Nassau Bay, are always hazardous, not only by reason of gales, but also because of the dreaded williwaws. These small cyclonic winds often drop down without warning from the mountains and, whipping up the surface of the water, whirl their way across it. Sometimes several williwaws may occur at once. I have seen trees covering part of a distant mountain-side suddenly go down like ninepins before a williwaw which did not strike the water until a quarter of a mile or more from land. The force of the williwaw has been known to make a small steamer surge at her chains, and I know of a case where it picked up a small towed boat, spun it round on the end of its painter, and shot it beneath the waves. Consequently, with a craft like the *Garibaldi*, it was sometimes a matter of dodging a number of these at once or of quickly downing sail. My futile attempt to reach Cape Horn in the half-logged river-boat with Yahgans before mentioned was frustrated by this danger of williwaws as well as by the beginning of a gale. Yahgans are sometimes marooned on outlying islands, and even on Horn Island itself, for such extended periods as to face starvation, and on occasion it has become a question of killing and eating human flesh that the fittest might survive. The first night of my arrival at Rio Douglas my sleep was broken by the weird cries of the Yahgans, borne in on the storm, in lament for two of their number murdered the night before. After this mourning, they destroyed the property of the deceased. It is their custom not to mention the names of the dead thereafter.

Little wonder that the mentality of the people of these storm-racked, sombre regions is coloured by their depressing environment. This tribe and the Onas, in view of their primitive conceptions, freedom from the multiplicity of civilization factors and cultural advancement, offered a rare and profitable ground for the modern psychologist. Here was almost a virgin field of particular import in the study of a psycho-analytic interpretation of the mental conceptions of a primitive people, particularly in regard to taboo as an expression of emotional ambivalence, which tendency is much stronger in primitive than in civilized peoples. Because of the complexity of his life, psychoneuroses in a civilized adult may be so involved as to defy analysis. In the civilized child the organization of a psychoneurosis is usually very simple, but when adult life is reached he has left behind all the factors of his childhood life which tend to produce his adult characteristics. Now among adults of primitive races such as the Yahgans however, where the mental organization is far less complex than that of civilized man, certain psychoneurotic disturbances are found which, if analysed, might disclose the mental mechanisms of these

disturbances reduced to their simplest terms. The Yahgan's environment has a very direct bearing and influence on his character. Consequently, for the psychologist to acquire a clear comprehension of the Fuegians' mental organization, it is essential for it to be based on certain geographical and anthropological data. Certain facts which I secured corroborate the well-known ideas of sexual repression as elaborated by Freud, and the mental organization of both the Yahgans and the Onas seems to substantiate certain psycho-analytic conceptions. Unfortunately the rare opportunity for this work is all but past, and the people themselves are nearly extinct.

Although the physical character of the country and the climate has forced the Yahgans to split up into small groups and family units to obtain food, yet they are instinctively gregarious, and foregather whenever and wherever food happens to be temporarily plentiful, as, for instance, in the case of a stranded whale. Then canoes come from many directions in answer to their signal smokes. The Yahgan almost invariably transports his fire, a smouldering bit on a patch of clay, in the bottom of his canoe. Though the Yahgan has no word for any numeral beyond three, it is an astonishing fact that he has a vocabulary of nearly 40,000 words. This fact is well established through the remarkable work in the form of an Anglo-Yahgan dictionary and grammar compiled by the pioneer missionary, the Rev. Thomas Bridges.[1] Their songs, though weird and in a minor key, are not unpleasing, based as they are on a language pleasantly euphonious, abounding in the vowel and consonant sounds of the English tongue. It was my privilege to secure the first phonographic records of the Fuegians' songs and speech. These comprise eleven records, seven of which are Yahgan, the rest Ona.

Yahgan songs may be classified under three main heads: play songs, symbolical songs, and ceremonial songs. Their play songs may have no particular significance, even the words themselves in some cases being meaningless, and they are sung for the pure joy of singing. Their symbolical songs are imitative of nature, often involving facts or characteristics of animal life, such as the song called A'pow'woosh or Song of the West Wind, the Shruckoosh or Song of the White Kelp Gander, or their Song of the Mollymauk. The mollymauk is a wild sea-bird which inhabits the regions of Cape Horn. When singing the Shruckoosh, the singers squat in a circle in a wigwam, and during the singing nod their heads to imitate the bird's movement. At the finish they all, with outstretched arms, flap their hands and give vent to a loud, then diminishing, "Sh-sh!" imitating the sound and movement of the birds' wings as they fly away. Regarding ceremonial songs, while the Jacous, a play song, might be classified as such, the one which could be placed definitely in this category is the Fuegian death-chant, "Hi, muttawagoo! hi, muttawagoo!" (He is gone! he is gone!), the song I mentioned hearing at Rio Douglas. The Jacous song shows Yahgan singing at its best, with perhaps more feeling for real music than any other I know of. It is sung in chorus by a number of Yahgans

[1] The Rev. Thomas Bridges will undoubtedly stand as the greatest authority on the Yahgan tribes, and the stupendous work of his Anglo-Yahgan dictionary a fitting monument to him. The history of the peregrinations of this dictionary is a story in itself. The MS. is now in the hands of Professor F. Estermann and Dr. Martin Gusinde, of Vienna.

gathered together in their playhouse or sort of community lodge called Jacous, in reality an extra large wigwam. They open this song by a sudden loud shouting laugh—a pause—then faintly begin a long weird chant, which gradually swells louder and fuller, then stops—a long pause—then a final prolonged laugh ends the song. My records of Yahgan songs show the characteristic emphatic and wavering sound-giving qualities known of nearly all Amerinds, north as well as south. They also show the primitive character of the Fuegian melodies, which beside their shortness of motives are generally restricted to two tones, with its falling melodic inflection. The Yahgans use half-tone intervals as leading notes, while in their method of voice-uttering they display the most characteristic feature of all Amerind singing. No one who is a close observer would mistake an Amerind song for one outside the two Americas. So far as is known, these phonographic records are the first ever made of Fuegian song and speech, and in the opinion of Dr. Ernst Von Hornbostel, of Berlin University,[1] "they are more primitive than any other Amerind songs so far known."

After spending a little more than two months among the Yahgans, I cruised down Beagle Channel from Remolino eastward in a whale-boat with Martin Lawrence, and then followed through the coastal forests. The forests of Fuegia are the southernmost limits of arboreal vegetation, reaching as far south in South America as they do north in North America. Although these two great continents are, generally speaking, similar in shape, their configuration in relation to the tropics is reversed. North America widens towards the north to a stretch of over 3000 miles in the latitude of 54° north in Southern Labrador; South America narrows southward until, in a corresponding latitude south, through the middle of Fuegia, it is but 250 miles wide. However, the climate of corresponding latitudes south seems to be less detrimental to plant life than that of corresponding latitudes north, probably owing to the influence of the oceans. Deciduous forests are a dominating feature of the vegetation in both the eastern and western hemispheres in the north temperate zone, but in the southern hemisphere this type of vegetation is restricted to a very limited area; in fact the only strip of deciduous forest in the southern hemisphere is along the east side of the Andes, extending southward from sub-tropical Argentina and Chile through the temperate zone across sub-Antarctic Fuegia. But the southern deciduous forest stands out in striking contrast to the northern, in that it is composed of a single generic type, the so-called Southern Beeches, *nothofagus antarctica* and its congeners.

As the South American continent continues to taper south, from the Rio Negro (40° south) through Patagonia, across the Straits, through Fuegia to Cape San Diego (54° 40′ south), we have three distinct longitudinal topographical zones: the coastal zone of the Patagonian archipelago on the west, the cordillera of the Andes or central zone, and the broader zone of the pampas on the east, which gradually narrows to the Andes and terminates in southeastern Tierra del Fuego. Coincident with these topographical zones are

[1] The original phonographic records are in the possession of the author. A duplicate set was sent on request to Berlin University. This set was later transferred to Dr. Martin Gusinde at his request, with the object of incorporating a study of the records in his present work on the Yahgans.

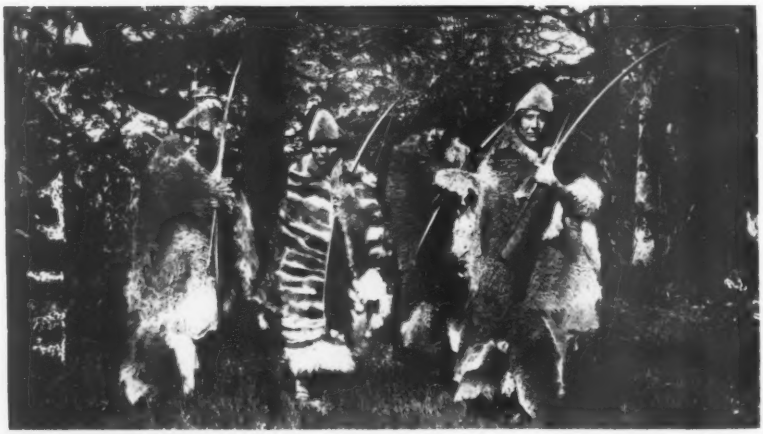
Last survivors of the Haush race: full-blooded Haush with Yahgan wife on right and half-breed Yahgan-Haush wife on left

Lauí, south coast of Tierra del Fuego: Yahgans throwing spears

Yahgans at Rio Douglas: woman standing with mourning face-painting

Ona arrow-maker and family under travelling shelter of guanaco skin

Ona warriors in south-eastern Tierra del Fuego



Ona hunters, members of the Furlong expedition

three distinct zones of vegetation: rain forest, deciduous forest, and desert. This desert pampa region, which forms the easterly part of Patagonia and Fuegia, is arid, wind-swept, and with a comparatively small rainfall, and consequently supports a distinctly desert vegetation. The westerly slopes and coastal edges of the Andean ranges form a region of perpetual rain and fog, and present the other extreme of climate; lying between these two extremes along the lower easterly slopes and base of the Andes is the belt of deciduous forests. The vegetation of the desert zone comprises a rather sparsely growing bunch grass (*festuca gracillima*) resembling the festuca of the Scottish moors, and it is upon this grass that the wild guanaco and the great herds of sheep feed. The only shrubs in these treeless plains are the low-growing *mate verdi*, the *mate negro*, and, the largest, a scant-growing bush, a sort of Barbary known as *calafati* (*berberis*), whose hard, gnarly roots produce the only firewood of those plains. The central vegetation zone, containing the long belt of deciduous forests, nearly 1000 miles in length and rarely exceeding 50 miles in width, is a transitional region lying between two extremes, and like similar areas supports a unique and diversified vegetation. The westerly or rain-forest zone is evergreen sylva, the most abundant element of which is the non-deciduous species of this same genus *nothofagus*.

I reached Harberton, the home of the Bridges family, at the beginning of January 1908. With this as my headquarters my great problem in further outfitting for penetrating Tierra del Fuego was now men and horses. Through some Yahgans, and with the help of Mr. William Bridges, I got in touch with a hunting party of Onas who had crossed Beagle Channel from Navarin Island in Yahgan canoes on their way to the interior of Tierra del Fuego for the winter. Four of this party, including an Ona named Aanakin, a man of individuality, came to the outskirts of the Bridges's ranch for a conference with me. Big, wolfish, cinnamon-coloured men they were, each clothed only with a single guanaco skin and a triangular head-dress from the front of which fell their coal-black hair, cropped in long bands at their eyebrows. They were armed with bows and finely fashioned arrows, the latter carried in otter-skin quivers. The making and use of the Ona's sole primitive weapon, the bow and arrow, are a story in themselves, but his method of arrow release alone should be of great interest in the study of that factor as an element in historical inter-tribal and inter-racial association. Mr. Will Bridges discouraged me from going, stating, among other things, that to his knowledge Aanakin had murdered thirteen people, two of them white men, and that he was an untrustworthy Ona. This bore out what they had told me in Punta Arenas: that no explorer could get through this country; that the Onas were cannibals, used poisoned arrows, and even if contact were made these men would knife with one hand while receiving a gift with the other. Besides, the country was impassable and the Onas would shoot from ambush. All but the last accusation I later proved to be false. However, Bridges kindly aided me as interpreter, and the Ona, after taking three days to consider the matter, assented to my going with them, the main condition being that I should provide Aanakin with a Winchester rifle and ammunition before our departure. Meantime Bridges sent three friendly Onas overland along the coast to Sloggett Bay, with a note to purchase horses in charge of some Chileans, left at an abandoned mining camp on its lonely shores.

The Onas returned with about a dozen horses and a mule, from which I selected three animals, including the latter. These, with Aanakin's mare, brought my number of animals to four. I understood that this was the first time this journey had been made through the coastal forest by land to Sloggett Bay: it certainly was the first time that horses had ever traversed it. Some idea of the difficulties may be gathered from the fact that it took the Onas, two of whom carried axes to hew the way, nearly three days to cover the 38 or 40 miles by foot and six days to make the return journey with the horses. The horses arrived in poor condition from their struggle through forest and bog, and even the Onas showed signs of fatigue. The horses were a strange-looking lot. They had been running free for nearly a year on the soft ground about Sloggett Bay, with no opportunity of wearing down their hoofs, which in consequence had grown to inordinate length, curling up at the ends like old-fashioned skates.

The policy which I have adhered to on all but my recent Central African expeditions of going light and going alone, never proved more efficacious than on my Patagonian and Fuegian expeditions, particularly through the Land of the Ona. Every pound had to be considered, because of the scarcity of horses and the boggy going, which was the hardest I ever experienced. On more than one occasion it became a question of whether to abandon horses or to abandon cargo. My food comprised rice, Indian corn-meal, sugar, salt, compressed tea, *Erbswurst* (compressed ground peas for soup), and a slab of salt pork, all of which, with my films, were carried in waterproof cotton food-bags. To this was added half a sheep's carcase, obtained from the Bridges's ranch, which was lashed on top of one of the packs. Besides food, there were ammunition, tent, tarpaulin, bedding, camera supplies, anthropological measuring instruments, the phonograph, and a dozen wax cylinders. After taking phonographic records of Tininisk, an Ona *joh'n* (medicine-man), one of the hunting-party, and trimming my animals' hoofs, I left Harberton with four Onas. Going alone with natives has a number of advantages. Two or more white men, speaking a language the natives do not understand, arouse suspicion, usurp much time which should be spent with the natives, and make them pyschologically much less natural. Two white men make a native feel he must have eyes in the back of his head; one white man inspires confidence and trust, and they always know just where he is. Besides, in exploring alone with natives, one has his ethnological laboratory constantly before him to which he can give his undivided attention. Consequently, being the only white man adds to one's safety—provided he is "muy simpatico," without which human touch the ethnologist is greatly handicapped. I always considered a mouth organ an important detail of my equipment and sometimes used it to great advantage.

The insistent rain had raised grave doubts as to the possibility of making an expedition over the mountains with horses. However the early morning of our departure broke fair. Heading a little west of north we soon passed a small lake, with wild duck, and rounded a corner of a mountain, pushing on through woods all the way, and in about three hours of difficult travelling we forded a small river, and then climbed over another small mountain. We now continued on a long descent, always through woods and boggy land. This going was extremely hard on the animals, and also dangerous from the risk, not only of their being bogged, but of slipping on roots which slanted from the trees

beneath the muck, or of being impaled on sharp-pointed shafts which stuck out from the clutter of hard-down timber. We forded one small river and some streams at least one hundred and thirty times that first day's journey. These proved now and again difficult to cross, although late that afternoon the icy waters of one served for our trail through the impenetrable forest. As we followed up-valley in it, we passed one remarkable dark conformation of rock on our right.

Of the rain-forests Darwin writes: "In the deep ravines the death-like scene of desolation exceeded all description . . . gloomy, cold and wet was every part . . . the valleys . . . were completely barricaded by great mouldering trunks which had fallen down in every direction . . . one's course was often arrested by sinking knee-deep into the rotten wood. At other times, when attempting to lean against a firm tree, one was startled by finding a mass of decayed matter ready to fall at the slightest touch." It was this rain-forest that presented the greatest obstacle to my journey across Tierra del Fuego. Some further idea of the difficulties of travel over this terrain may be gathered from the experiences of a botanical party from Captain Cook's ship, H.M.S. ***Endeavour***, which on 16 January 1769 went ashore near Good Success Bay just east of Sloggett to climb a low mountain by the coast in search of plants. They were prepared for a journey of eight or ten hours, intending to return that night. They had ten hours' food supply, shot a vulture which was divided, were not more than 4 miles from their ship at any time and could have seen her from a tall tree, yet because of boggy swamp, interwoven, unbendable bushes, wind, light snow, and cold, exhaustion and starvation forced them to stay on the mountain all night, and they were unable to get back under thirty-seven hours. As a result, even in this short space of time they lost two of their twelve men, a third was desperately ill, and a fourth had fits. "A dreadful testimony," writes one, "of the severity of the climate, as it was now the midst of summer in this part of the world."

Between Beagle Channel and the eastern end of Lake Cami was the most difficult travelling I have ever experienced, and it was only by the remarkable guidance and skill of my Onas that we got through. Great portions of the southern half of Tierra del Fuego were too impenetrable, mountainous, and swampy to be occupied even by the aborigines, and it was generally conceded that most of the rest was impassable to any one but an Ona. Our trail led through dense sub-Antarctic jungle which covered the valleys and mountain slopes to the tree-line, a jungle soaked by rain the greater part of the year, and this late summer the slopes had been drenched with an almost perpetual rainfall. This persistent rain resulted not only in making a veritable quagmire in many places in the low, valley, swamp lands, but in turning portions of the mountain slopes themselves into *pantano* (bog); consequently every one of the animals was frequently bogged, the main cargo horse getting in deep four times during the first day's journey. This meant taking the entire cargo off a half-sunken animal, helping him out, and then loading on the cargo again. Care and judgment were necessary not to force a horse unduly; this may discourage him from further efforts, and lead to his being abandoned.

The forests which creep their way up the mountain sides are composed principally of the tough evergreen beech trees (*nothofagus antarctica* and

nothofagus betuloides) and various shrubs. After an altitude of about 1800 feet the forests thin out, and the trees become so stunted and interwoven that one can at times walk on their tops. In many places in these forests tough tangles of distorted, dwarfed beeches are found, so impenetrable at times that every step of the way must be hewn with an axe. From their twisted branches hang long festoons of pale, grey-green moss, lichens blotch the trunks, a parasitic growth forms great knobs on the limbs, and the sweet-tasting, mucilaginous fungi (*Cyttaria Darwinii*), a staple food of the Onas, cling in round, pitted orange-coloured balls. Beneath, soft mosses carpet the ground, in which one sinks knee-deep, or more likely a swamp makes it doubly impenetrable. Saturated and dripping the greater part of the time with moisture or rain, or covered with a white blanket of snow, no other such forest life is said to exist. One finds among the mosses and along the wood edges delicate ferns, yellow violets, orchids, cranberries, compositae, and other plants. But perhaps one of the most beautiful shrubs in the world is a flaming red, honeysuckle-like plant ; the Yahgans call it *mugoo*. As one cruises about the channels its flowers paint on the hillside broad patches of beautiful red against the darker background of sombre green. In Fuegia the flowers have practically no odour, but on bright, sunny days, which sometimes do occur in this weird, sombre land, they make the wood edges and grasslands quite gay in midsummer (December 21). But the chief difference between this region and its equivalent northern latitude is not the greater degree of cold in winter, but the greater want of warmth in summer, and the excessive rainfall, which in the vicinity of Cape Horn is 60 inches per annum, although it is decidedly less in south-eastern Tierra del Fuego.

I pitched my first camp about halfway up the southern slopes of the range, in the great rain-forest. But no sooner had we unsaddled the horses, and with no little difficulty started a fire, than increasing conditions of rain forced us to saddle-up and carry on, for more rain would have marooned us, and it was necessary to negotiate the rest of the up-slope before it was further soaked. So I named this Hungry Camp, as we were hungry when we got there and hungry when we left. Persevering upwards in the sub-Antarctic twilight, at 10 p.m. we reached the stone-line at about 2000 feet. Here a veritable clutter of rocks covered the top slopes of this mountain, known to the Onas as Chechen. A few hundred feet below, in a saddle of the mountains to the south-west, lay the first patch of the previous winter's snow. Above us was a long reach of the rocks with a stretch of perpetual snow covering Chechen. At the edge of the snow-line the unshod horses refused to budge. Accustomed as they had been to the soft terrain of Sloggett Bay, the jumble of hard, edgy stones of a clay slate character proved too much for their tender feet. Only after considerable encouragement and gentling were they induced to proceed. These rocks, no less than the hard, crusted snow we later reached, proved painful going to the heavily-laden, bare-footed Ona women, one of whom was with child. The pass lay between Chechen and a slightly higher mountain to the east of it. Skirting just below the *cumbre* (crest) towards midnight I glimpsed a faint streak of Antarctic light on the southern horizon; then we passed over the divide into darkness. Our sudden abandonment of Hungry Camp, where we had expected to eat, and our forced march afterwards, had left us eighteen

strenuous hours without food; so, with our hunting-knives, my Onas and I cut slices from the sheep's half-carcase, and ate them raw with ravenous satisfaction. In darkness, a hazardous down-slope was negotiated and camp made.

The next morning Aanakin's mare gave birth to a foal, a beautiful little black thing with a white-tipped nose and a white diamond in its forehead. Less than three hours after it was born it started with its mother on life's rough journey along with our outfit through bog, glacial streams, and a drenching rain until seven that night. It not only lived but throve. Here one finds the winter's bark the tallest kind of tree, and I noticed that in the interior the trees were larger. This day's journeying was also a tremendous strain on the horses. Firm ground simply did not exist; it was just a question of bog or less bog, and the only hard footing we experienced, except in crossing the *cumbre*, was the treacherous rocky beds of the torrential icy streams in which we sometimes travelled and were continually fording. On the third day I entered the following in my field note-book: "Crossed mountain-side. More bog. Left streams. Cargo horse ran away. Passed beautiful valley with open spots in woods with sweet-smelling grasses and buttercups. Wild parrots. Great wall of rock; woods with great drifts of fallen trees everywhere. No sounds but occasional bird-calls, wind, or creaking of trees." There is a great dearth of botanical, zoological, and entomological species in Tierra del Fuego. Unlike Labrador, Fuegia contains but few insects and no mosquitoes, blow-flies, frogs, lizards, or crickets. At the end of three days of the hardest travelling of my experience, during which we covered about 25 miles, we pitched camp a little way from the mouth of a small river, near the south shore of Lake Cami.

While exploring the southern shores and vicinity of the eastern part of Lake Cami, we camped on a low, hilly plateau, and near the lake edge which was being eaten away by wind and water erosion. Across the lake, almost due north, were two prominent peaks, one of which I judged to be a little more and the other a little less than 2000 feet. Of short duration was my swim in this lake, fed as it was by the innumerable streams from the snow-topped and glacial mountains which ranged its entire length of nearly 50 miles, with an average width of about 4 miles. The shore-line of this lake, except the extreme eastern and western ends, still remains to be accurately charted. Pitching my next camp just beyond the north-eastern corner of Lake Cami, I made an excursion along the north shore of the lake.

Nearly two months after I pitched my camps on the south and north shores of the eastern end of Cami, Dr. Carl Scottsberg, of the Swedish Magellanic Expedition, pushed through from Admiralty Sound and reached the western end of Cami. Some of the valuable and interesting results of this expedition have already been published in this *Journal* (vol. 31, pp. 642–645). The travelling from Admiralty Sound to the western end of Cami appears to have been even worse than from Beagle Channel to its eastern end, for Scottsberg, after citing Nordenskiöld's failure to reach the lake itself in 1895, states that "at the first trial our horse was bogged nine times on an average, had to be unloaded and helped in its struggle to get out of the dreadful peat. But our destination was Cami, and the rest of the way we had to carry everything on our backs." Apparently they started out from Admiralty Sound on about March 1 and took about a week, for he continues: "On March 7 however we

pitched our tents on the shore [of Cami] . . . It seems perhaps strange that a distance of 10 miles takes such a time to travel, but in this case one must not judge from mere figures."

Passing from the beach round the eastern end of Lake Cami, going northward through a copse of beeches across a peat-covered lagoon, we ascended a steep incline to an open grassy plain, covered with a scattered forest of burnt trees, like a city of spectres, while grey masses of cloud followed up from behind the snow-capped mountain peaks towards Admiralty Sound. Then we rode through rather open woods, festooned with pale, feathery moss, which seemed to illumine the forest with a faint, grey-greenish light. The country now became more open, where, constantly drenched with rain, we crossed moorlands of moss and grass, undermined in every square yard in some areas by the little ground-rat (*cururu*). We had finished the half sheep and depended on our rifles for meat. On one occasion shortness of food reduced us to an owl, but in the more open land north of Cami I was fortunate to shoot a guanaco. About 6 miles a little northwards of the eastern end of Cami we made camp near a small lake. From here, alone with Aanakin, I pushed into the wilderness, back of the two mountains before mentioned, and south of some larger lakes, and would have continued farther but for the fact that this region, as I learned from Aanakin, was the hunting-ground of a group of Onas, enemies of his and his clan. From now on the northern country was more open and totally different in character from any of that south of Cami. It was in this country that I came into contact with groups of different Ona clans with whom I lived, travelled, and hunted. I eventually arrived, with my worn-out animals, at Rio del Fuego, on the east coast, where I was hospitably received by Mr. Lucas Bridges, who was opening up a new estancia there.

The results of this expedition included written and photographic records of a large amount of ethnological data of the Fuegian tribes, hand- and foot-prints, phonographic records of their songs and speech, ethnological collections[1] of their artifacts, etc. Valuable botanical collections[2] from both Tierra del Fuego and Patagonia together formed one of the largest, if not the largest, single collection brought out of these regions, numbering one hundred and sixty-six species of flowering plants, the main portion of which is now in the Botanical Department of Cornell University. Work on all these collections is now being done with a view to publication. The evaluation of the work of this expedition should be of particular scientific importance, in view of the fact that the records were made while these tribes were, comparatively speaking, numerically strong, particularly the Onas, and also when some of the latter were still living the primitive life of men of the Stone Age; but since that time the Onas, like the Yahgans, have been reduced, principally by measles, from perhaps eight hundred to a scant one hundred, the Yahgans from about one hundred and seventy-five to probably less than fifty, while the Haush, or eastern Ona, with the exception of one or two individuals, are now extinct.

[1] The ethnological collections, some of the largest extant, are principally in the American Museum of Natural History, Peabody Museum of Harvard University, Heye Museum of the American-Indian, and the Peabody Museum, Salem, Mass.

[2] Sets of this collection are now in the Herbaria of Cornell University, New York Botanical Gardens, and the Gray Herbarium at Harvard University.

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: It has been the practice of Presidents—a practice I have attempted to follow—in introducing the lecturer, I will not say to create but to induce an atmosphere by which the lecturer can at once feel himself in the country he is about to describe. I confess that I find it somewhat difficult to do so in the case of Tierra del Fuego, for it is a very little-known country. There are present those who have written of it—Lord Conway and Mr. Barclay; there are not very many others who know the country. Recently, after I had been speaking about a country of which I had not previously known much and which was generally very little known, some one said to me, "You must have read about that in a book," to which I replied, "I assure you I did not invent it, and I did not guess it." In the case of Tierra del Fuego I suppose there would be envisaged a stormy barren country and coast, a canoe, some poverty-stricken natives in it, nearly naked, a fire burning in the middle of the canoe on a little raised platform. But there are other aspects of the country, and it is of those aspects we shall hear to-night from Colonel Furlong, our lecturer.

Colonel Furlong has travelled in many countries and is a man of great experience in travel. I will not attempt to enumerate all the countries he has visited or his experiences, because I should keep you here all night listening to me instead of to him. He is a citizen of the United States of America, and in that connection I am glad to take the opportunity of welcoming here the new American Consul-General who has just come to us and who will always be welcome in this Society. Anyhow, I feel, as many of you may, that I am setting out on an adventure to a new country which will be fulfilled by listening to a lecture which I now ask Colonel Furlong to deliver.

Colonel Furlong then read the paper printed above, and a discussion followed.

The PRESIDENT: One of the episodes in the varied life of Lord Conway was, as you have heard, the climbing of Mount Sarmiento. I will ask him to address us.

Lord CONWAY: I have had very clearly recalled to my mind a remembrance of the short period that I spent in Patagonia and Tierra del Fuego. I cannot say that it is a very agreeable or festive remembrance, for I have never visited a country that was more inhospitable; indeed, it was a very uncomfortable country. I was there in midsummer and it was raining all the time; I was told it was the dry season! One result of all the rain is the peculiar conditions of vegetation. There are islands, the continuation of the Andes, which go right down the Fuegian archipelago, and are densely forested. I cannot imagine any afforestation so dense as that which I saw. To travel about 100 yards took us several hours, during which time we did not once touch the ground, but walked over a matted mass of fallen trees rotting, others growing upon the fallen ones; all kinds of nasty moss and growth holding things together. Indeed, one never got within 10 feet of the ground. Marching, if it can so be called, meant treading from one fallen tree to another. That type of forest is, I think, peculiar to the district.

When Darwin was in the Cockburn Channel—the channel the lecturer no doubt correctly referred to as Magdalen Channel—at the foot of Mount Sarmiento, he described a glacier coming down into the Cockburn Channel, with icebergs falling off the edges. When I was there there were several such glaciers ending in the sea, but they may since then have withdrawn. At all events, there was one in Darwin's day, and our way across the bottom of Sarmiento lay exactly where Darwin's glacier had been, but we had to go at least half a mile inland before

we came to the glacier at all. That is to say, that since Darwin's time the glacier had retreated from a quarter to half a mile, and the whole of the newly disclosed land from which the glacier had retreated was covered with a matted forest, not young trees but a matted forest of trees that had grown and fallen to the ground and had allowed others to fall and grow on top of them. As we made our way through a corner of that forest we had curious proof of the great rapidity with which that kind of forest is formed. Darwin was there one hundred years or so before I visited the country: in a century the whole of that matted mass of growing, rotting and decaying forest had been formed on that area of newly exposed land.

Our attempt to ascend Sarmiento was very interesting to me. In the early part of the climb we had wonderful views, but as we went higher up it became evident that the weather was not going to remain fine for much longer: a storm was coming down from South America and was evidently very near at hand. When it burst upon us we had to turn round and quickly make our way back. I have been in bad storms in my life in the mountains, but never in a storm so terrific as that was. We had watched its approach, and it passed on over the Straits of Magellan, down the Cockburn Channel; massive, dark black clouds with a kind of pallid snow beneath them, pallid horrible stuff. We managed to get down from the mountain in time, otherwise I am sure I should not have been here.

I could talk about Tierra del Fuego till the ships come home, but all I can allow myself to do now is just to give you that impression of the violence of the storms out there, the density of the vegetation, and the inhospitability of a great part of the country to man. There are pampa parts which are suited for sheep culture about which I need say nothing. I was interested in the wild parts of the country which are still very little known and hardly explored.

The PRESIDENT: It would take a long time to follow all the matters of interest which have been brought forward by a lecture such as we have listened to; all the different tribes of Indians and the references which the lecturer made to others. How is it that the Eskimo has learned to clothe himself, to feed himself well, to live in some comfort, while the Southern Indian lives miserably and is disappearing? The only answer one can give, apparently, to the latter question is, as the lecturer has said, the approach of civilization. Whether that is a happy or unhappy thought, it is not one which we need discuss to-night.

Lord Conway and also Colonel Furlong have mentioned the gales and what you may call the desolate weather. It is a long time since I went round the Horn, for I went round in 1875. But I know the weather is such that at Cape Horn it can raise a wave which, from trough to crest, is 40 feet in height. When you consider that this hall is between 30 and 35 feet in height, you will realize what the weather is like to create a wave such as that. When we recall that in days gone by people went round those latitudes, past Cape Horn and through the Straits of Magellan in ships of 200 to 300 tons, if as big, we have much to be thankful for in regard to our forebears.

We are very grateful to you, Colonel Furlong, for a most interesting lecture. I ask you to accept on behalf of this audience and the whole Society our warmest thanks not only for the work you have done but for the way in which you have described it.

METEORITE CRATERS AS TOPOGRAPHICAL FEATURES ON THE EARTH'S SURFACE: *A paper read at the Afternoon Meeting of the Society on 16 January 1933, by*

DR. L. J. SPENCER, F.R.S.

THE problem of meteorite craters is quite a new one. Until 1927 the only known example was the "Meteor Crater" in Arizona, which since 1892 has been the subject of much discussion and controversy. Various theories have been put forward to explain its origin. The one most generally accepted at the present time is that the crater was formed by the impact of a gigantic meteorite on the Earth's surface; but this view still finds some opponents. Strong support was given to this theory by the discovery made in 1931 of a group of craters near Henbury in Central Australia.[1] But definite proof was finally given by the remarkable discovery made by Mr. H. StJ. Philby during his crossing of the Arabian desert early in 1932. The search for the legendary city of Wabar was graphically described by him at a meeting of this Society on 23 May 1932. The "walls" of the city were found to be the rims of a series of craters, and the abundant "cinders" of the city "destroyed by fire from heaven" proved on examination to be a nearly pure silica-glass. Near by rusted pieces of meteoric iron were also found, the largest remnant weighing 25 lb.

The finding of the silica-glass, as cindery and slaggy masses and as complete "bombs," was in itself a remarkable discovery, for no similar material had ever been found before, and it was found in great abundance. Silica-glass is, in fact, of rare occurrence in nature. It is best known in the form of fulgurites or lightning-tubes, which are formed when sand-dunes are struck by lightning.[2] Since a temperature of about 1700° C. is required to melt quartz sand, the development of a large amount of heat is here indicated. Further, the smaller pieces of meteoric iron from Wabar when sectioned, polished, and etched show a partial destruction of the characteristic structure, such as can be brought about artificially by heating the material to about 850° C.

Now the close association of silica-glass and meteoric iron with a group of craters in a sandy desert can be accounted for in no other way but by the impact of a shower of large meteoric masses. We have, in fact, at Wabar a typical example of meteorite craters.

It is my present purpose to give some account of the few meteorite craters or supposed meteorite craters that have so far been discovered, in the hope that the scanty information at present available may be of some help to travellers in recognizing further examples. There are many crater-like depressions on the Earth's surface, but it would be rash to assume that all have been formed by the fall of meteorites. Some other pieces of evidence must be sought for. Nothing is yet known of the mechanics of the formation of such craters. They

[1] A. R. Alderman, "The Meteorite Craters at Henbury, Central Australia," *Mineralogical Magazine*, 1932, vol. 23, pp. 19–32, 2 pls. L. J. Spencer, "Meteorite Craters," *Nature*, 28 May 1932, vol. 129, pp. 781–4.

[2] Mr. Philby's collection, from localities other than Wabar, includes a few small fragments of fulgurites, which were found in hollows between the sand-dunes. An interesting fact is that the Arabs regard them as indications of the presence of water.

are not merely dents or holes made just by the projectile force of the meteorite, as hitherto supposed. They appear rather to be explosion craters due to the sudden vaporization of part of the material, both of the meteorite and of the Earth, in the intense heat developed by the impact.

The meteorite craters so far described may be easily remembered by the following classification, with two examples in each class:

Single craters with associated meteoritic material (Arizona and Texas).

Groups of craters with associated meteoritic material (Central Australia and Arabia).

Groups of craters without associated meteoritic material (Estonia and Siberia).

Single craters without associated meteoritic material (Ashanti and Persia).

This makes a total of eight examples. It seems a pity to disturb this beautifully symmetrical arrangement, but farther on I shall add a third example to the second class, while the third and fourth classes are not proven and the last example is more than doubtful. That leaves only five more or less certain examples of known meteorite craters.

The Arizona crater (Plates 1 and 2) was first brought to notice in 1891 by the discovery of many masses of meteoric iron scattered around the crater.[1] The finding of diamond in this iron aroused a considerable amount of interest and not much notice was at first taken of the crater itself. It was known locally as Crater Mountain or Coon Butte, and was afterwards called Meteor Crater. The irons are known as the Cañon Diablo meteorite from the Cañon Diablo near by. The locality is situated in Coconino County in the desert of north central Arizona and close to the Santa Fé railroad.

The crater is a basin-shaped depression approximately circular in outline with a maximum diameter of 3950 feet and a minimum diameter of 3850 feet, or three-quarters of a mile. Its depth is 570 feet. The outer slopes rise gently

[1] A. E. Foote, "A New Locality for Meteoric Iron with a Preliminary Notice of the Discovery of Diamonds in the Iron," *Amer. Journ. Sci.*, 1891, ser. 3, vol. 42, pp. 413–17, 2 pls.; and *Proc. Amer. Assoc. Adv. Sci.*, 1892, vol. 40 (for 1891), pp. 279–83.

Accounts of the crater have been given by:

G. K. Gilbert, "The Origin of Hypotheses, illustrated by the Discussion of a Topographical Problem," *Science*, New York, 1896, vol. 3, pp. 1–13, 2 pls.; and Presidential Addresses, Geol. Soc., Washington, 1896, pp. 2–24, 18 figs.

D. M. Barringer, "Coon Mountain and its Crater," *Proc. Acad. Nat. Sci. Philadelphia*, 1906, vol. 57 (for 1905), pp. 861–86.

B. C. Tilghman, "Coon Butte, Arizona," *ibid.*, pp. 887–914.

L. Fletcher, "A Search for a Buried Meteorite," *Nature*, 1906, vol. 74, pp. 490–92.

G. P. Merrill, "The Meteor Crater of Canyon Diablo, Arizona; its History, Origin, and Associated Meteoric Irons," *Smithsonian Miscell. Collect.*, 1908, vol. 50, pp. 461–98, 15 pls.

D. M. Barringer, "Meteor Crater (formerly called Coon Mountain or Coon Butte) in Northern Central Arizona," paper read before the National Academy of Sciences, 16 November 1909; privately printed [Philadelphia, 1910], 24 pp., 18 pls. "Further Notes on Meteor Crater in Northern Central Arizona," *Proc. Acad. Nat. Sci. Philadelphia*, 1915, vol. 66 (for 1914), pp. 556–65, 3 pls.; 1925, vol. 76 (for 1924), pp. 275–8, 1 pl.

For more recent short notes see *National Geogr. Mag.*, Washington, 1928, vol. 53, pp. 721–30. *Science*, New York, 1929, vol. 69, pp. 485–7; 1930, vol. 72, pp. 463–7; 1931, vol. 73, pp. 38–9, 66–7. *Scientific American*, July, August, and September 1927; June 1932, p. 363. *Engineering and Mining Journal*, New York, 1932, vol. 133, p. 392.

from the surrounding desert plain to a height of 130 to 160 feet at the rim, while the inner slopes are steep and precipitous, and partly covered with talus. The bottom is level (410 feet below the plain) with an area of over 300 acres, and was once occupied by a lake as shown by the presence of lacustrine deposits up to 88 feet in thickness. In the surrounding country the beds of sandstone and limestone (of Carboniferous age) are horizontal, but in the walls of the crater they dip radially outwards at angles of 10° to 80°, and in one place are faulted. The outer slopes are covered pell-mell with fragmentary material ranging in size from blocks of rock estimated to weigh over 4000 tons down to the finest "rock-flour." Fragments are littered about for a distance of 6 miles from the centre, and they were evidently ejected from the crater, the largest blocks being nearest the rim. Indiscriminately mixed with this material, and also buried in it, have been found thousands of pieces of meteoric iron ranging in weight up to 460 kilos (1014 lb.) and also pieces of laminated iron-shale resulting from the weathering of the iron. About 20 tons of the iron has been collected, but inside the crater only four small pieces have been found and relatively little of the iron-shale. It is obvious that this meteoric material must have been ejected from the crater at the same time as the blocks of sandstone and limestone.

Besides diamond, the Cañon Diablo meteoric iron contains 7·33 per cent. of nickel and small amounts of the precious metals platinum and iridium. One assay gave platinum 3·65 and iridium 14·95 grams per metric ton. It therefore seemed to offer a promising mining venture, the supposition being that the main mass of the large meteorite, perhaps 500 feet across[1] and weighing over 14 million tons, that formed the crater would be found buried inside. Mining claims were taken out by the Standard Iron Company in 1903 and many trial shafts (six) and bore-holes (twenty-three) were put down at considerable expense, but nothing of value was found. After passing through crushed and metamorphosed sandstone and abundant rock-flour, undisturbed sandstone was met at a depth of 620 feet. The metamorphosed sandstone shows a partial fusion of the grains of quartz and grades into a friable and porous silica-glass.[2]

Another company, the Meteor Crater Exploration and Mining Company, was formed in 1927, and a new drill-hole was put down through the southern wall of the crater (under the supposition that the meteorite had entered at a slanting angle). After passing through 30 feet of iron-shale cementing fragments of metamorphosed sandstone, the drill stuck at a depth of 1376 feet, presumably against some hard object, which was believed to be the main mass of the meteorite. An attempt was then made to sink a shaft outside the crater to a depth of 1500 feet from which the mass could be reached by a cross-cut, but at a depth of 640 feet a heavy flow of water was encountered and the work had to be abandoned, after the expenditure of 293,000 dollars. Attempts are now being made to raise funds for further exploration.

All this work, which has added much valuable detail to a knowledge of the

[1] A small asteroid of 1500 feet diameter has also been suggested. This, composed of meteoric iron, would have a mass of 378 million tons.

[2] A. F. Rogers, "A Unique Occurrence of Lechatelierite or Silica Glass," *Amer. Journ. Sci.*, 1930, ser. 5, vol. 19, 195–202, 9 figs. This silica-glass is more like a sintered sandstone: it does not show the effects of complete fusion, as at Wabar.

crater, was carried out by the late Mr. Daniel Moreau Barringer, of Philadelphia, who was an enthusiastic supporter of the meteorite theory; and it is now being continued by his son, Mr. D. M. Barringer, Junr. Under the guidance of Mr. Barringer the crater was examined in detail by the late Dr. George P. Merrill, of the United States National Museum, and eventually he became an adherent of the meteorite theory. Previously this theory had been rejected by G. K. Gilbert, of the United States Geological Survey, in favour of the theory that the crater had been formed by a volcanic steam or gas explosion without the extrusion of any lava. Although there are no volcanic materials in the immediate neighbourhood of the crater, yet there are extensive basaltic flows at a distance of 10 miles, and the extinct volcanoes of the San Francisco Mountains are only 30 miles away. There are still supporters of this theory; but it does not explain the intimate intermingling of shattered terrestrial rocks with meteoritic material, nor the presence of silica-glass. It would be a strange coincidence for such a volcanic outbreak to take place just at the spot where masses of meteoric iron had previously fallen, and they certainly could not have fallen afterwards. Further, the temperature of a steam explosion would not be high enough for the production of silica-glass. The same, and more, objections would apply to the theory that the crater has been formed by the solution of limestone, being of the nature of a sink-hole.[1] The crater extends downwards into sandstone, far beneath the base of the bed of sandy limestone.

The Arizona crater, like the craters of Henbury and Wabar, shows an intimate association of meteoric iron and silica-glass with fractured terrestrial rocks, and it was undoubtedly formed by the fall of a large meteorite. But whether the main mass of this meteorite still lies buried in the crater is extremely doubtful.[2] More probably such portions as were not vaporized by the intense heat developed by the impact were shot out by the gaseous explosion and scattered around the crater.

The Texas crater[3] is situated about 9 miles south-west of Odessa in Ector County. It is a shallow depression roughly circular in outline with an average diameter of 530 feet. The rim is about 18 feet above the bottom of the hole, but only 2 or 3 feet above the surrounding desert plain where horizontally bedded limestone is exposed. The steep inner slopes show the limestone dipping at 20° to 30° away from the centre. A much-rusted fragment (1120 grams) of meteoric iron was found here in 1922, and the crater was first mentioned in 1927. Amongst the fragments of limestone and sandstone forming the rim of the crater a few more small pieces of iron have been found together with numerous pieces of iron-shale. The various suggestions made to account for the origin of this crater are discussed by E. H. Sellards, namely: (1) volcanic explosion; (2) salt dome; (3) expansion by hydration of anhydrite; (4) explosion of gas; (5) fall of a meteorite. The last is considered to be the most probable, and this view is supported by D. M. Barringer.

[1] F. S. Dellenbaugh, "Meteor Butte," *Science*, New York, 1931, vol. 73, pp. 38–9.

[2] The only known case of a meteoric iron found *inside* a crater is mentioned below under Henbury.

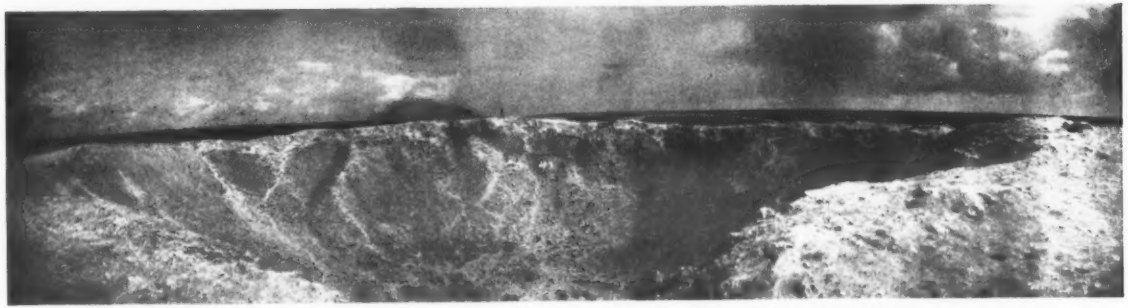
[3] E. H. Sellards, "Unusual Structural Feature in the Plains Region of Texas," *Bull. Geol. Soc. Amer.*, 1927, vol. 38, p. 149.

D. M. Barringer, Junr., "A New Meteor Crater," *Proc. Acad. Nat. Sci. Philadelphia*, 1929, vol. 80 (for 1928), pp. 307–11. No pictures are available of this crater.

1. Air photograph of the meteorite crater in Arizona (*p. 228*). (*Carnegie Institution of Washington*)

2. Arizona crater: ejected blocks forming rim. (*D. M. Barringer*)

3. Inside the main meteorite crater at Henbury, Central Australia (p. 231). (Mineralogical Magazine 1932)



4. Mine crater, La Boisselle, Somme, 1916 (p. 242). (Imperial War Museum copyright)

The Henbury craters (Plate 3) in Central Australia, known locally as the Double Punchbowl, are situated 7 miles west-south-west of Henbury cattle station on the Finke river, about 50 miles south of the MacDonnell Ranges. Pieces of meteoric iron having been sent from there to the University of Adelaide with the statement that they had been found around crater-like depressions, Mr. A. R. Alderman at once proceeded to the locality in May 1931, when he was quick to recognize the importance of the discovery.[1] Within an area of half a mile square he mapped thirteen craters, and around them he collected more than eight hundred pieces of meteoric iron, together with much iron-shale and some black glassy material. At one spot over an area of 6 by 6 feet more than a hundred small pieces of iron were picked up. The largest crater is oval in outline, 220 by 120 yards across, and 50 to 60 feet deep. The others are approximately circular with diameters ranging from 10 to 80 yards and depths from 3 to 25 feet. With their gently sloping outer surfaces the craters are not very conspicuous until one stands on the rim, when the steep inner slopes come into view. The craters are however marked out by the growth of mulga trees, acacias, and coarse grass, since they act as collecting pans for rain-water in this arid region (average rainfall 6 inches per annum). The steep inner walls consist of powdered rock and shattered blocks of sandstone, quartzite, and slate of Ordovician age. Only at one spot in the walls were the rocks seen to be apparently in situ and with the same dip as in the surrounding country. A feature that may perhaps be of some significance was noted by Mr. Alderman around two or three of the craters, but best seen around crater No. 3, which is 45 yards in diameter. Here, radiating from the rim, are five or six low ridges of sandstone, only a few inches in height and varying considerably in length, the average length being about 30 yards. It is suggested that these may have resulted by the percussion of the meteorite. Only two pieces of iron (one of 13 lb.) were found inside one of the craters, and these on the surface just inside the rim. A boring in the floor of crater No. 5 (25 yards diameter) passed through 8 feet of fine silt down to rock fragments, but no iron was found.

A large amount of material, together with much valuable information about the Henbury craters, has been sent to the British Museum by Mr. R. Bedford, of the Kyancutta Museum, in South Australia, who visited the locality in June 1931 and May 1932. This includes 642 pieces of the iron with a total weight of 891 lb. (405 kilos). The largest pieces weigh 292, 170½, and 120 lb., but the majority are small and curiously twisted and curved. A selection of this material is on exhibition in the Natural History Museum at South Kensington. Most interesting is a group of four irons with a total weight of 440 lb. excavated in 1932 from a depth of 7 feet inside the smallest crater. They were found in contact and with much flaky rust between and around them, and they are evidently the weathered remnants of a single mass. Immediately around and beneath the iron were broken blocks of rock, while the overlying material was fine-grained and free from big stones. This crater (No. 13 on Alderman's map) is only 10 yards in diameter and 3 feet in depth; and in this case

[1] A preliminary illustrated account was published in the *Adelaide Chronicle* of 16 July 1931, and a more detailed account in March 1932 (*op. cit.*). A few further details respecting the craters are given by A. R. Alderman, "The Henbury (Central Australia) Meteoric Iron," *Rec. S. Austr. Museum*, 1932, vol. 4, pp. 555–63, 9 figs.

the explosion was evidently not sufficient to "back-fire" the main mass out of the crater. Around the crater sixty small twisted pieces of iron were found, together with fragments of iron-shale, but no silica-glass. Excavation of the rather larger 15-yard crater (No. 11) gave a negative result.

The larger blocks of the Henbury iron when sectioned, polished, and etched show the normal lamellar octahedral structure (Widmanstätten figures) of a medium octahedrite. In the smaller twisted and curved pieces the lamellae are bent and twisted. Further, the kamacite is granulated, proving that here the temperature exceeded 850° C. Oxidation of the iron has proceeded along the curved cracks, along which the pieces eventually break up. These curiously twisted and curved pieces therefore seem to be weathered remnants of pieces of the iron which were torn, perhaps in a plastic condition, from the main masses by the force of the explosions. The corroded surfaces and the normal internal structure shown by the larger pieces of the iron indicate that these also are only weathered remnants of still larger masses, in fact merely the cores to which the intense heat had not time to penetrate by conduction. Pieces of iron-shale are also found in abundance around the craters. These, especially when found buried, are sometimes clustered together in the form of "shale-balls," in which occasionally a core of unoxidized iron still remains.

Silica-glass has so far been found only around the largest crater at Henbury, but not in the same perfection and abundance as at Wabar; and being formed by the fusion of a ferruginous sandstone it is less pure. It shows a curious distribution on the ground, for which no explanation can be offered. On the west side of the crater larger cindery and cellular masses and pieces of partly fused sandstone are found close to the rim; while on the east side small tear-shaped drops and threads with a smooth glossy surface are found along a narrow strip of ground extending eastwards a mile from the crater.

At Henbury there must have been, not a single mass, but a shower of large masses of iron that formed the group of craters. The large oval crater, which shows a promontory on its longer side, was doubtless formed by two masses falling close together at the same time.

The Wabar craters, discovered by Mr. Philby[1] in February 1932, are in the Rub' al Khali at 21° 29½′ N., 50° 40′ E. (Plates 5 and 6). Two distinct craters were mapped with indications of two others buried in the sand. Isolated patches of the slaggy material suggest that still more craters are buried. The larger crater is approximately circular in outline with a diameter of 100 metres and a depth of 40 feet (10½ metres). It shows a long gap in the rim on the northern side. The smaller crater, 200 metres distant from the first, is oval in outline with dimensions of 55 by 40 metres. The outer slopes are gentle and the inner slopes steeper, and the bottom is filled with drifted sand. For a distance of about 40 metres from the rim the outer slopes are thickly strewn with cindery masses of silica-glass and smaller complete bombs of the same material, ranging in size down to small "black pearls" which were picked up in large numbers.

The rims of the craters appear to be built up mainly of this silica-glass. There are no rock fragments except as small angular pieces of a sintered sandstone enclosed in the larger masses of silica-glass. Near the craters there is a

[1] *Geogr. J.*, vol. 81, January 1933, and his forthcoming book.

small outcrop of a friable cream-coloured sandstone composed of small shattered grains of quartz, and this presumably extends beneath the desert sand and the craters.

On the outer slopes of the craters there were also collected a few small pieces of meteoric iron and fragments of iron rust. A much-rusted mass of meteoric iron weighing 25 lb. was found about 200 metres north-west of the smaller crater and nearer one of the buried craters. This must be only a weathered remnant of a much larger mass, as it shows the normal octahedral structure unaffected by heat. In the smaller pieces the kamacite is granulated. The group of craters indicate that here there must have been a shower of large masses or iron.

The reason for the unique development of silica-glass at Wabar is no doubt that the large masses of iron fell on clean desert sand. A remarkable feature of the bombs and black pearls is their extreme lightness. Inside they consist of a very cellular, white silica-glass, and they are coated with a thin skin of black glass, usually with a highly glazed surface and often beset with minute pimples. The black glass is brown and transparent, with only a few minute bubbles, when examined in thin sections under the microscope. Chemical analysis shows it to contain some iron and a small amount of nickel in addition to silica. These structures suggest that there was a pool of molten and boiling silica (the silica vapour causing the highly cellular structure), and that a rain of molten silica was shot out from the craters through an atmosphere of silica, iron, and nickel produced by the vaporization of the desert sand and part (perhaps a large portion) of the meteorite. The minute pimples on the surface were dewdrops from these vapours formed in the last stages.

The group of craters in Estonia are on the Baltic island of Oesel (=Saare Maa) at 20 km. north-east of Arensburg (=Kuresaare) on the farm Sall (=Kaali) (58° 24′ N., 22° 43′ E.). They have long been known and often described, first by J. von Luce in 1827. They have been thought to be earthworks made by man, and they have been compared with the crater lakes of the Eifel and the Campi Flegrei. Other modes of origin that have been suggested are that the craters were formed by (1) gas explosions, (2) oozing out of a bed of clay, (3) weathering of limestone, (4) expansion of solution of salt anhydrite. In 1922 J. Kalkun compared them with the Arizona meteorite crater. Recently, in 1927 and again in 1929, a detailed survey with borings and trenches has been undertaken by J. A. Reinvaldt, Inspector of Mines in Estonia, and he comes to the conclusion that the craters were formed by the fall of a shower of iron meteorites. While his work was in progress a visit was made to the locality by E. Kraus and R. Meyer of Riga, and Alfred Wegener of Graz, and he freely supplied them with full details and drawings. As a result they published a long joint paper, which appeared only shortly after Reinvaldt's own paper.[1] Kraus inclines to the view that the craters were formed by the solution of the salt in

[1] I. Reinwaldt with A. Luha, "Bericht über geologische Untersuchungen am Kaalijärv (Krater von Sall) auf Ösel," *Tartu Ülikooli juures oleva Loodusuurijate Seltsi Aruanded* (*Sitzungsber. Naturfors. Gesell. Univ. Tartu*), 1928, vol. 35, pp. 30–70, 8 pls. Separate as *Publ. Geol. Inst. Univ. Tartu*, 1928, no. 11, pp. 1–42, 8 pls.

E. Kraus, R. Meyer, and A. Wegener, "Untersuchungen über den Krater von Sall auf Ösel," *Gerlands Beiträge zur Geophysik*, 1928, vol. 20, pp. 312–78, 1 pl., 10 text-figs.; Nachtrag, pp. 428–9.

salt-domes; but Meyer and Wegener, while considering this mode of origin to be possible, favour the meteorite theory as the more probable.

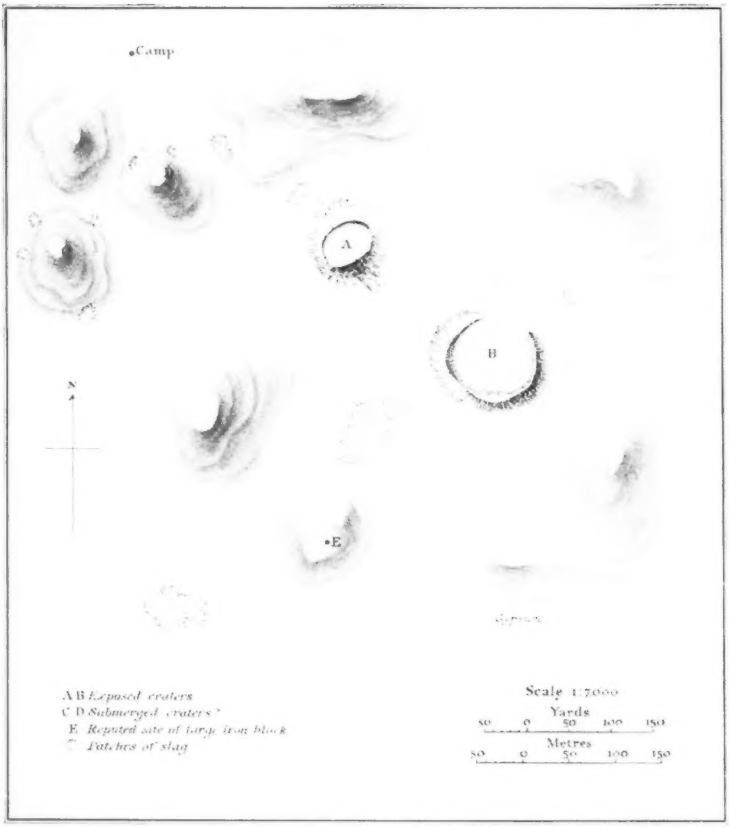
The main crater, which is occupied by a lake, is nearly circular in outline with a diameter of 92 to 110 metres. Its rim is 6 metres above the surrounding ground, while inside the depth is 15·5 metres. The steep inside walls show beds of dolomite (Silurian age) dipping away from the centre at angles of 30° to 40°. Beneath this there is a zone of pulverized rock containing rock fragments; and the rocks at the bottom of the crater are shattered. Five other smaller craters, irregularly distributed over an area of $\frac{3}{4}$ square kilometre, are described in detail. Four of these are circular in outline with diameters of 10 to 39 metres and depths of 1 to 4 metres. The fifth is oval, 53 by 36 metres, suggesting that two masses of iron fell together. In the bottom of one of these smaller craters the shattered bed-rock shows an impression which is believed to represent the dent made by the meteorite. Reinvaldt supposes that the craters were formed by violent steam explosions, steam being suddenly generated from the ground-water in the rocks by the heat of impact of the meteorites, and that the meteoric iron was shot out from the craters together with rock fragments. There are indications of other small craters that have been filled with stones collected from the land. A mantle of glacial deposits about a metre in thickness covers the ground. This is intermingled with the rock debris of the craters, proving that the craters are post-glacial.

No meteoritic material has been found at this locality. The absence of masses of iron is explained by the fact that the ground has been tilled since time immemorial.[1] But pieces of iron-shale should have been found in the excavations in the rims of the craters. Silica-glass would, of course, not be found, as the surrounding rock is dolomite.

The Siberian craters (Fig. 1, Plates 7 and 8) are rather disappointing, showing only as a series of small pools in a swamp. It is certain that some catastrophic event occurred there on 30 June 1908, but its exact nature still remains doubtful. Unfortunately no good and connected account has yet been given, but sensational reports appear periodically in the newspapers. The best account, collected from the available scraps of information, is that recently given by Dr. Whipple.[2] Only after a lapse of several years, in 1921, were inquiries made in the neighbourhood of Kansk by Dr. Leonid A. Kulik, who is Curator of the Meteorite Department in the Mineralogical Museum of the Academy of Sciences at Leningrad. A fireball had been seen and loud explosions heard over a wide area, blasts of hot air were felt, and an earthquake recorded at Kansk and Irkutsk, as well as at Tashkent, Tiflis, and Jena. Air waves had also been recorded on the microbarographs at Cambridge, London, Reading, and Petersfield in England, though they were not deciphered until 1930 by Dr. Whipple. Then it was remembered that remarkable midnight glows and twilight had been seen in Europe and Siberia

[1] A similar explanation is given for the absence of meteoric iron in India (as contrasted with the United States of America and Australia). Of the 106 recorded Indian meteorites only one is a found iron.

[2] F. J. W. Whipple, "The Great Siberian Meteor and the Waves, Seismic and Aerial, which it produced," *Quart. Journ. Roy. Meteorological Soc.*, London, 1930, vol. 56, pp. 287–304, 4 figs.



5. Plan of the Wabar craters, Arabia (p. 232). (H. St J. Philby)

6. Meteorite crater at Wabar, Arabia. (H. St J. Philby)

7. Fallen forest 10 miles from centre of explosion, Siberia (p. 234). (Dr. L. Kulik)

8. Siberian explosion, 1908: craters in swamp. (Dr. L. Kulik)

9. Shell holes, Aisne, June 1918 (p. 242). (Imperial War Museum copyright)

on 30 June 1908 and the following nights. Mention of a "meteorite" [*i.e.* meteor, for no meteorite has even yet been found] was made by Dr. Kulik and others.[1]

In 1927 and 1928 Dr. Kulik[2] was able to locate the place of the fall, being led to the spot by the devastated forests. Pine trees are felled radially outwards for a distance of 60 kilometres (37 miles) from the centre, the area of devastation covering several thousand square kilometres. A fourth expedition was made in 1929–30, when Dr. Kulik spent twenty months at the locality, but his new results are not yet published. He has however generously imparted some of the information,[3] and I have to thank him for a long letter of September 1932 and several photographs.

The spot is on the watershed between the streams Khushmo and Kimchu, which flow respectively into the Chambe and Chunya, both tributaries of the Podkamennaya (Stony) Tunguska, at 60° 55′ N., 101° 57′ E.[4] The nearest settlement is Vanovara, on the Stony Tunguska, 80 kilometres to the south-east. The centre of the fallen forest is near the southern limit of permanently frozen ground, which is here at a depth of half a metre. In winter there is a half metre covering of snow, and the minimum temperature recorded in December 1929 was minus 56° C. In summer it is a region of peat bogs and mosquitoes. The rocks of the region are fine-grained and coarse basalts overlain by glacial deposits and peat. Only on the hills are rock exposures occasionally seen.

In the swamp are numerous round depressions—ten according to some accounts and two hundred according to another—ranging in diameter from 10 to 50 metres and up to 4 metres in depth. Around the area of these "craters"

[1] P. Tschirwinsky, "Meteorit vom 30. Juni 1908 im Ausflussgebiet der Flüsse Tunguska in Sibirien," *Centralblatt Min.*, 1923, p. 550.

A. V. Voznesensky, "Fall of a Meteorite on 30 June 1908 in the Upper Course of the Khatanga River" [Russian], *Mirovédénié, Bull. Soc. Russ. des Amis de l'Étude de l'Univers*, 1925, vol. 14, pp. 25–38, with small sketch-map.

S. V. Obruchev, "On the Place of the Fall of the Great Khatanga Meteorite in 1908" [Russian], *ibid.*, pp. 38–40, with small sketch-map.

L. A. Kulik, "On the Connexion of Meteorites and Comets," *ibid.*, 1926, vol. 15, pp. 173–6 [Russian], pp. 177–8 [English]. "Les météorites du 30 juin 1908 et l'orbite de la comète Pons-Winneke" [Russian], *Compt. Rend. Acad. Sci. U.R.S.S.*, ser. A, 1926, pp. 185–8. Here is also described the fall of a meteoric stone of 1·9 kg. at Kagarlyk, 60 km. from Kiev, Russia, at 7 a.m. on 30 June 1908. The Siberian fall was at 0h. 15m. (G.M.T.) on the same day.

[2] L. A. Kulik, "Sur l'histoire du bolide du 30 juin 1908," *Compt. Rend. Acad. Sci. U.R.S.S.*, ser. A, 1927, pp. 393–8. "Sur la chute de la météorite 'Podkamennaja Tunguska 1908,'" *ibid.*, pp. 399–402, with sketch-map. "Auffindung des tungusischen Riesenmeteors vom 30 juni 1908," *Petermanns Mitt.*, 1928, vol. 74, pp. 338–41, with sketch-map. [Translation from *Krasnoyarsk Workers' News* of 9 August 1927.] A notice of this appeared in the *Geogr. J.*, 1929, vol. 73, p. 296. Abstracts of these papers and of all other recent literature on meteorite craters are given in *Mineralogical Abstracts* issued with the *Mineralogical Magazine*.

[3] J. G. Crowther, "More about the Great Siberian Meteorite," *Scientific American*, 1931, vol. 144, pp. 314–17, 9 figs. 'Osiris and the Atom,' London, 1932, pp. 23–39, 4 figs.

C. P. Olivier, 'Comets,' London, 1930, pp. 198–205, 2 pls.

[4] These differ from the latitude and longitude previously stated. In his letter of 9 September 1932 Dr. Kulik gives the position of "Mt. Farrington," determined by him astronomically in 1929, as φ 60° 54′ 58·98″, λ 101° 56′ 59·79″.

the peat is thrown into concentric ridges. A trench cut through one of these ridges showed contorted folds of peat, clay, and ice. Three borings were made to a depth of 31·5 metres at the edge and in the centre of one of the round depressions. Under the covering of peat there was permanently frozen clay down to 25 metres, and below that a sandy deposit which was not penetrated.

One view is that these depressions are formed by the freezing of water in

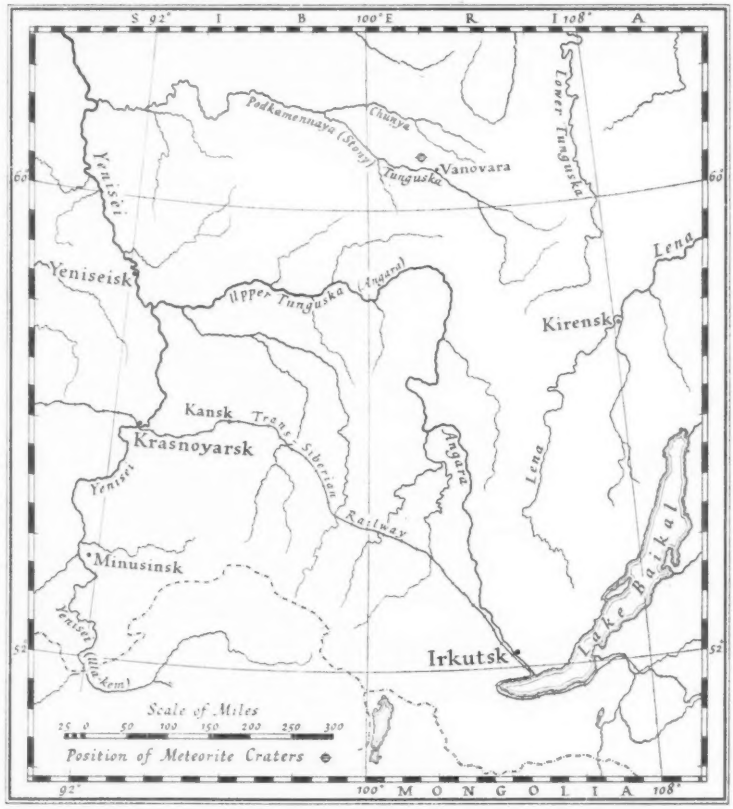


Fig. 1. Place of fall of the Siberian meteorite of 30 June 1908

cavities between the permanently frozen ground and that frozen only in winter, causing expansion and afterwards bursts. They are said to be of normal occurrence at the southern limit of permanently frozen ground. This view is opposed by Dr. Kulik. Another view is that they were formed by the solution of limestone, salt, or gypsum[1]; but this is at once ruled out by the bed-rock

[1] P. Tschirwinsky, "Ueber die Pseudometeorkrater in Arizona und auf der Insel Ösel," *Mém. Soc. Russe Min.*, 1931, ser. 2, vol. 60, pp. 135–44, 4 figs. [Russian with German summary].

being only basalt. Dr. Kulik believes them to be really meteorite craters, though he himself suggests some alternative explanations. They may have been formed by the folding of the surface layers by the blast of hot air, or by flooding following the melting of the frozen ground, or by smaller still warm masses of meteoric iron lying on the frozen ground. None of these explanations however appears to be satisfactory, and it is indeed doubtful whether these small depressions are at all comparable with those of Henbury and Wabar. No trace of meteoritic material has been collected by Dr. Kulik, but he was told by the natives that pieces of iron were formerly found in the central area of the fallen forest.

The Ashanti crater[1] occupied by the large circular lake of Bosumtwi lies on a watershed at 6° 30′ N., 1° 25′ W. It is roughly circular in outline with a diameter of about $6\frac{1}{2}$ miles and a depth to the surface of the lake of 900–1200 feet. The gentle outer slopes merge into the surrounding upland 300–600 feet below the rim, which is higher on the south side. The lake is nearly 5 miles across and 240 feet in depth, and its surface is 600 feet below the surrounding country. Pre-Cambrian phyllites exposed in places in the steep inner slopes show the same strike and dip as in the surrounding country. Granitic rocks, but no volcanic rocks, are present in the neighbourhood. The view of the Gold Coast Geological Survey that the crater is due to faulting is not accepted. A gas explosion is not probable, and Dr. Maclaren suggests that the crater was formed by the fall of a large meteorite. But no meteoritic material has been found, and there is no shattering of the rock walls, and no fragmentary material in the rim.

The supposed crater in Persia was shown to General Dyer[2] in 1916 by his native guide Idu as a curious hole in a level plain near Gwarkuh (28° 30′ N., 60° 40′ E.) in the Sarhad district of Persian Baluchistan. The hole was then 150 feet long, 120 feet wide, and 50 feet deep with absolutely perpendicular sides. Idu said that it had been only half its present size, but twice as deep, and that his grandfather remembered how and when it was made. The old man told him that one night, when he was a youth, something exploded in the sky, and falling to the earth had punched a hole 100 feet deep in the plain. The spot was visited by C. P. Skrine[3] in 1921, who gives the dimensions as 95 by 70 feet, with a depth of 35 feet. At the time of a later visit in 1929 it had silted up by 3 feet. The picture given by Skrine shows a vertical hole through horizontal strata (apparently alluvial deposits), and it does not in the least suggest a meteorite crater.

The Campo del Cielo craters (Fig. 2) in Argentina may now be added to the list of known meteorite craters. The locality is situated in the Gran Chaco on the border between the province of Santiago del Estero and the Chaco Nacional, and around the railway station Gancedo (27° 28′ S., 61° 30′ W.). Native iron has been known from this district since 1576, when it was discovered by

[1] Malcolm Maclaren, "Lake Bosumtwi, Ashanti," *Geogr. J.*, 1931, vol. 78, pp. 270–6, 2 pls., 4 text-figs.

[2] Brigadier-General R. E. H. Dyer, 'The Raiders of the Sarhad,' London, 1921, pp. 85–6.

[3] C. P. Skrine, "The Highlands of Persian Baluchistan," *Geogr. J.*, 1931, vol. 78, p. 328.

Hernán Mexía de Miraval. Rubín de Celis[1] in 1783 saw a mass which has been variously estimated to weigh $13\frac{1}{2}$ to 45 metric tons, and a few large masses have since been collected. One weighing 1400 lb. was presented to the British Museum by Sir Woodbine Parish in 1826. At the place is a group of round and shallow depressions (*hoyos* or *pozos*), the largest, 78 by 65 metres, being occupied by a lake, the Laguna Negra, the rim of which rises only 4 feet above the surrounding level pampa. These have recently been examined by Dr. J. J. Nágera,[2] the Chief Geologist of the Argentine Survey, and excavations were made in the hoyo called Rubín de Celis (also called Pozo del Cielo). This

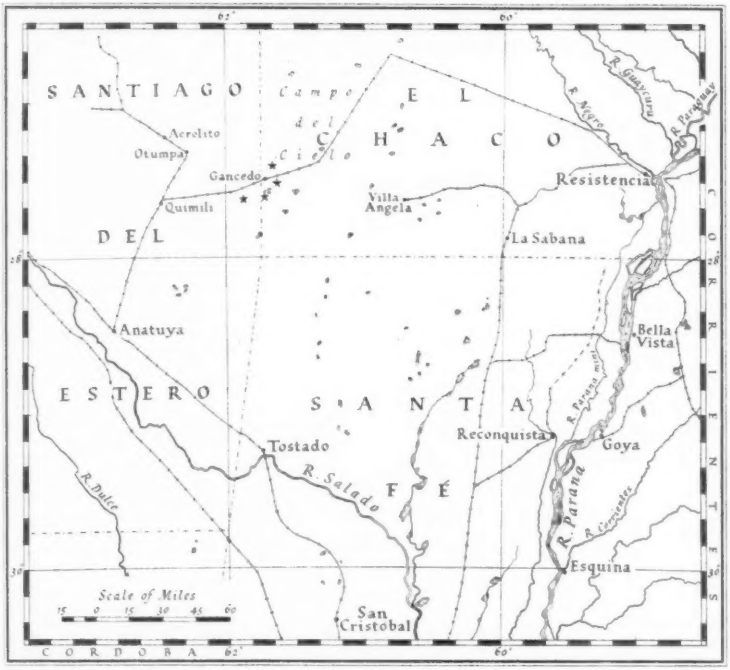


Fig. 2. Place of fall of the Campo del Cielo meteoric irons, showing numerous small lakes in the vicinity; stars indicate where masses of iron have been found

is circular with a diameter of 56 metres and a depth of 5 metres. Pits dug in the rim and in the centre of the depression showed disturbed beds of sandy loess mixed with "white volcanic ashes" and "transparent glass in angular,

[1] Michael Rubín de Celis, "An Account of a Mass of Native Iron, found in South America," *Phil. Trans. Roy. Soc. London*, 1788, vol. 78, pp. 37–42, 183–9.

[2] J. J. Nágera, "Los hoyos del Campo del Cielo y el meteorito," *Dirección General de Minas, Geología e Hidrología, Argentina*, Buenos Aires, 1926, publ. no. 19, 9 pp., 19 pls. This report is reprinted with some of the plates by Antenor Alvarez, 'El meteorito del Chaco,' Buenos Aires, 1926, 222 pp., 2 maps, 16 figs., where a detailed historical review is given.

curved, and striated pieces." There are no volcanic rocks in the surrounding pampa, and the Andean volcanoes are 500 miles away. This transparent glass, if examined, would most probably prove to be silica-glass. Small fragments of rusted meteoric iron were found in one of the pits near the rim of the hoyo. A piece of typical iron-shale (very similar to that from Henbury) from this excavation was presented to the British Museum by Dr. Antenor Alvarez in 1927, but unfortunately none of the glass was sent. Dr. Nágera concludes that the hoyas were not formed by the fall of the masses of meteoric iron, but that they were made by man. There seems however little doubt that they are really meteorite craters. They are easily accessible and close to the railway, and should certainly be further investigated. There are other suggestive features worthy of investigation in this district. Many small lakes and pozos are scattered around; and in particular a chain of small lakes extends southward from the spot where the large masses of meteoric iron have been found for a distance of nearly 100 miles into the province of Santa Fé.

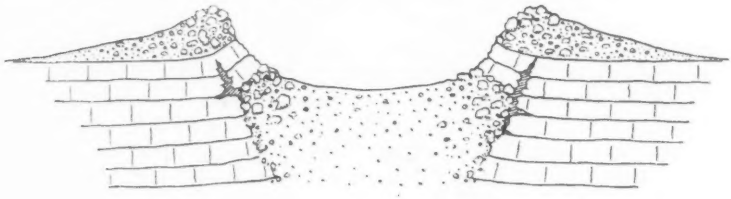
Summary of Characters of Meteorite Craters

The following tabulation of the dimensions of the described craters shows that there is a very wide variation in the ratio of width to depth. This ratio must be rapidly affected by denudation, and perhaps gives some indication of the relative age of the craters. This ratio will also depend on the type of rock, as shown in the two mine craters of La Boisselle and Hill 60.

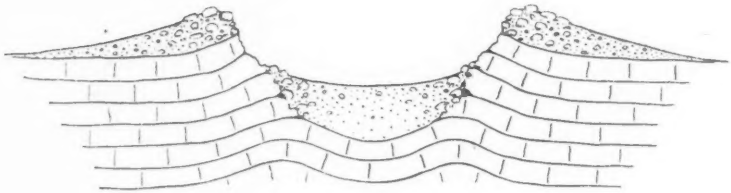
	Width	*Depth*	*Ratio of width to depth*
Texas	530 feet	18 feet	29·4
Ashanti	34,300	1300	26·4
Siberia	164	13	12·5
Campo del Cielo	183	16	11·4
Estonia	33	3	11·0
„	128	13	9·9
„	300	50	6·0
Henbury	30	3	10·0
„	240	25	9·6
„	360	60	6·0
Wabar	328	40	8·0
Arizona	3900	570	6·8
Hill 60, Ypres	340	67	5·1
La Boisselle, Somme	270	70	3·8

From the above accounts it will be seen that a certain amount of direct evidence is supplied only by the craters of Arizona, Henbury, and Wabar, and this has to be supplemented by a considerable amount of speculative deduction. Direct observation of how such craters are formed is of course quite out of the question. Meteorites of which the fall has been actually observed have always been of comparatively small size, and their velocity has been reduced by the resistance of the air to that of an ordinary falling body of about 70 metres per second. They make small holes, usually of not more than 1 or 2 feet in depth, in the ground. The largest meteorite of which the fall has been observed is a

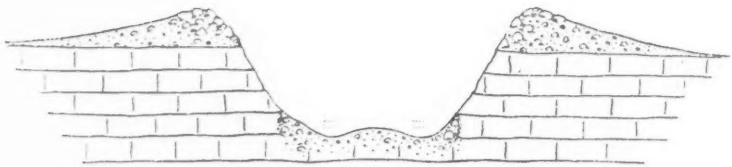
stone of 820 lb. which fell at Paragould in Arkansas on 17 February 1930. This penetrated clayey soil to a depth of 8 feet, scattering clods to a distance of 50 feet in the pasture. On the other hand, the largest known meteorites, all of which are irons and none observed to fall, have been found by reason of their being partly exposed at the surface of the ground. The 60-ton Hoba meteorite discovered in South-West Africa in 1920 has its upper surface level with the



a. Meteorite Crater: fracturing and tilting of strata by outward explosion



b. Meteorite Crater: ring anticline by percussion



c. Mine Crater at La Boisselle, France, 1916

Fig. 3. Diagrammatic sections of craters

surrounding ground, and around it there is no sign of a crater. The large masses of iron near Cape York in the north of Greenland were found loose on the rocky surface.

It seems therefore that meteorite craters are not merely dents in the ground made by the percussion of a meteorite; but that they are explosion craters due to the sudden vaporization of part of the material, both of the meteorite and

of the Earth, in the intense heat developed by the impact. When a large mass of iron travelling with planetary velocity is suddenly stopped, the kinetic energy ($\frac{1}{2}mv^2$) is transformed into heat at a localized spot with the development of a very high temperature. Simple calculations give very high figures.

The materials from the Henbury and Wabar craters give ample evidence of high temperatures. The transformation of kamacite from α-iron to γ-iron at 850° C. and the melting-points of iron at 1530° C. and silica at 1700° C. are definite points on such a "geological thermometer." We may further add the boiling-point of iron at 3200° C. and that of nickel at 3377° C. The boiling-point of silica has been estimated at a minimum of 2590° C., but this is probably too low. These are the boiling-points calculated for the pressure of one atmosphere, but under the enormous pressures produced by the explosions at the meteorite craters they must have been considerably higher.

The upward force of the explosion must be very much greater than the downward force of percussion; and for this reason the beds exposed on the inside crater-walls will dip radially outwards from the centre (Fig. 3*a*), instead of inwards towards the centre as might at first sight be expected. The outward dip could also perhaps be explained as in Fig. 3*b*, where a ring anticline has been formed by the percussion. The inner walls of the crater are always much steeper than the outer walls. The rim and outer slopes are formed of the fragmentary material shot out from the crater, and the amount of this material and the size of the blocks will show a gradual decrease with the distance from the centre. Some of the fragmentary material would also fall back into the crater and so cover up the shattered rock at the bottom. The known meteorite craters are all approximately circular in outline and their inner and outer slopes are symmetrical about the centre; that is, the craters are figures of rotation about a vertical axis. This is as would be expected in the case of an explosion crater; but in the case of a percussion crater it would happen only when the projectile strikes the surface normally.

The most likely place to search for meteoric iron would be on the rim and outer slopes, where much will be buried, perhaps to be exposed later by weathering processes. Meteoric iron readily oxidizes and breaks up. Buried fragments will give rise to the formation of more or less compact iron-shale and shale-balls, and these may be expected to be more persistent than the iron itself. Silica-glass can be formed only when the rocks surrounding the crater are highly siliceous, such as quartz sand or sandstone.

Natural and Artificial Analogies

Basin-shaped depressions, often occupied by lakes, are common enough on the Earth's surface, and they may be formed in several different ways. Volcanic craters and especially caldera (formed when the upper portion of a volcano is blown away by a violent explosion, or by subsidence of the cone) may be very similar in form to meteorite craters, but being composed of volcanic materials they are quite distinct. But in the case of explosion craters (or "embryonic volcanoes") an explosion of steam and volcanic gases may give rise to a crater consisting entirely of fragments of sedimentary rocks without the outpouring of any lava. Examples of these are the "maars" of the Eifel. The Pretoria

salt-pan[1] (3400 feet across and 400 feet deep), 25 miles north-north-west of Pretoria, and Lonar Lake, on the basalt plateau of the Deccan, have been thought to be such explosion craters; but the former presents more points of resemblance to a meteorite crater than does, for example, Lake Bosumtwi. Explosions of gas may also take place in oil-bearing regions, sometimes with the formation of mud volcanoes.

The craters on the moon are usually thought to be of volcanic origin, but the suggestion has also been made that they were formed by the fall of meteorites. Their large size is perhaps related to the smaller force of gravitation. If the meteoritic theory is here true, we can only hope that the Earth is not approaching the same stage.

Craters may also be formed on the Earth's surface by the solution of beds of limestone, or of pockets of rock-salt or gypsum.

As noted above, the craters of Estonia and of the Campo del Cielo have been considered by some authors to be earthworks made by man. This suggests that some other supposed earthworks may possibly be really meteorite craters. Many dew-ponds are clearly artificial, but some supposed to be of Neolithic age may possibly have been formed by the fall of meteorites. As examples of large holes made artificially in the Earth's surface mention may be made of the diamond mines at Kimberley and the still larger Premier diamond mine near Pretoria.

A closer analogy is given by the craters formed by military mines[2] and high-explosive shells. The mine crater of La Boisselle, on the Somme (Fig. 3*c*, Plate 4), exploded on 1 July 1916, was 270 feet in diameter from rim to rim and 70 feet deep. The rim consisted of debris piled up to a height of 15 feet above ground-level and the outer slopes extended to 90 feet beyond, the total diameter being 450 feet. In this mine two charges of 36,000 and 24,000 lbs., laid at 60 feet apart and 52 feet deep, were fired together. The positions of the two charges are shown on Fig. 3*c* by the dotted squares. They formed a circular crater of greater depth than the charges. One of the craters on Hill 60, near Ypres, was 340 feet across the rim, and 67 feet deep: here there was one charge of 70,000 lbs. of ammonal. These dimensions are comparable with those of the Henbury meteorite craters, but the craters here were in much softer rocks—chalk at La Boisselle and Eocene sand and clay at Hill 60. A photograph[3] of a devastated area on the Aisne in France, showing numerous water-logged shell-holes and stripped trees is extraordinarily similar to one of Dr. Kulik's photographs of the Siberian craters, only much more impressive (Plate 9).

As examples of much smaller craters produced by artificial means mention may be made of the splashes of drops[4] (also rain on mud flats), clay balls thrown on a slab of clay, and shots on armour plates.

[1] Percy A. Wagner, "The Pretoria Salt-pan, a Soda Caldera," *Mem. Geol. Survey South Africa*, 1922, no. 20, 136 pp., 19 pls.

[2] "Military Mining, Work of the Royal Engineers in the European War, 1914–19," *Institution of Royal Engineers*, Chatham, 1922.

[3] War Museum Photograph No. Q37361.

[4] H. M. Worthington, "The Splash of a Drop and Allied Phenomena," *Proc. Roy. Institution Great Britain*, 1895, vol. 14 (for 1894), pp. 289–303, 15 pls. R. S. Cole, "The Photography of the Splash of a Drop," *Nature*, 1894, vol. 50, p. 222. A. M. Worthington

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: The subject of the lecture this afternoon is technical and obscure. From the point of view of the origin of what we are going to consider, one might call it occult. This afternoon however we do not propose to touch, either in the lecture or the discussion, on the origins of the meteorite, but rather on its geographical and topographical effect. No one is more qualified or fitted to start such a discussion than Dr. Spencer. You all know him. He has made a special study of this subject. I will ask him to proceed to deal with his subject.

Dr. Spencer then read the paper printed above, and a discussion followed.

The PRESIDENT: We always welcome Sir Douglas Mawson here, whether as explorer, as seaman, or as a very adventurous character. This afternoon we welcome him as a geologist.

Sir DOUGLAS MAWSON: I have listened to Dr. Spencer's paper with very great interest, as I am sure we all have. He has brought together interesting facts relating to all the known and suggested meteorite craters that are yet recorded. Consequently, his is a valuable paper, and what he has deduced from data of measurements and other features of these craters is rather interesting. There is no doubt more of such craters will be found now that we are thoroughly keyed up to the possibility of their occurrence. Therefore it behoves us geologists to examine such features very carefully and tabulate information relating to them, so that they may be critically examined by mathematicians and others, because not all geologists are able to discuss the results of explosive violence thus evidenced.

I am not in a position to discuss this matter very far, but I am interested in the subject because, as Dr. Spencer has mentioned, there are very interesting examples at Henbury in the interior of Australia. We of the South Australian Museum and Adelaide University were the first scientifically to work upon and determine these as meteoric. Some geologists have, for long past, held that our mother Earth has been entirely built up of the accumulation, by infalling from space, of small solid meteorites, brought together under the influence of the ever-increasing gravity of the central mass. The exponents of that theory look for evidence of impact of meteorites on the Earth's surface, and of course found it many years ago in the Cañon Diablo crater in Arizona. But the evidence there was not fully satisfactory; for whereas investigation expected to find a large mass of meteoric iron embedded in the bottom of the crater, borings failed to reveal anything but fragments. It was however generally agreed it must be a meteorite crater. Now we have, as Dr. Spencer has indicated, evidence that that is beyond doubt. We now know there are numbers of meteorite craters in existence. We may expect to find more. This lends some support to the theory of earth formation from the accumulation of meteorites.

There is one point that impresses me. From the small size of the meteorites found in these holes, surely it must be that it is high velocity and temperature that have caused the unexpectedly great damage to the crust at point of impact. Dr. Spencer has stressed that point of view. When meteorites come at very high

and R. S. Cole, "Impact with a Liquid Surface studied by the Aid of Instantaneous Photography," *Phil. Trans. Roy. Soc. London*, ser. A, 1897, vol. 189, pp. 137–48, 8 pls.; 1900, vol. 194, pp. 175–99, 6 pls. A. M. Worthington, 'The Splash of a Drop,' London, 1895; 'A Study of Splashes,' London, 1908. Numerous interesting photographs are given in these books and papers, some of which bear a certain resemblance in form to meteorite craters.

velocity—some, of course, come at low velocity—the impact must be very great and produce a temperature sufficient to vaporize not only the water in the rock but also other substances normally solid.

Meteorites are not necessarily of the iron type. Others are composed entirely of stony material. Undoubtedly some are composed of substances much more volatile than others. More volatile varieties travelling at high speed might, on impact, do much damage to the crust but by volatilization leave little trace of themselves.

Iron meteorites are so unlike the normal rocks of the Earth's crust that they are easily recognized and recorded, but it is quite otherwise with stony meteorites. One which proved to be of such a nature was seen to fall near Adelaide about a couple of years ago. Its direction of flight was carefully noted, and after a few days' search it was found by Professor Kerr Grant. It was entirely stony and lay pulverized within a small crater. If this had not been found within a few days of its fall it would have become so weathered as to be unrecognizable. Probably many stony meteorites fall on to the Earth but are thus lost to record.

I have listened to the paper with very great interest and extend my thanks to Dr. Spencer for his valuable contribution on this subject.

The PRESIDENT: Dr. Harold Jeffreys is Reader in Geophysics at Cambridge. He is an eminent mathematician, and we would like to hear what he has to say on the subject.

Dr. HAROLD JEFFREYS: I really do not know very much about the subject, and all I can do is to raise one or two questions that rather badly need to be answered. There was one raised by Dr. Spencer which I think can be answered easily, about the bulging up of the strata at the edge of the crater. If you add a meteor to the Earth's surface the extra material must show somewhere. If the meteor does not simply lie on the surface it must push up the beds around the hole it forms. That seems to me quite easy, and as a matter of fact that is what happens, as Dr. Spencer showed in the photographs.

But the main question as to what happens during the actual impact of the meteorite seems to be extraordinarily difficult to answer. We learn in the text-books on elementary dynamics that if two solids come together at an ordinary velocity they separate afterwards in such a way that the normal velocity is in a fixed ratio to what it was prior to the impact. But there is no adequate theoretical explanation of this experimental fact even at ordinary velocities, and when we come to impact at planetary velocities an entirely new set of problems is raised. Dr. Spencer said the temperature would be raised a million degrees if the whole of the kinetic energy was converted into heat. But the question is, how is it done? When two bodies come together, the transformation of the energy into heat is not instantaneous. What seems to me to happen is that as soon as they come together there is violent pressure at the region of contact. That sends out an elastic wave in each of the two bodies, which travels with extreme velocity, and the stuff at the back of the meteorite comes down with its original velocity until the wave reaches it. Now this wave cannot have a greater intensity than the strength of the material, which therefore limits the change of velocity when the wave reaches any given part of the meteor. It will not be sufficient to stop the motion, so that the whole thing comes on with practically its original velocity, presumably until it hits the ground with the molecular cohesion already completely dissolved; that is, it becomes a gas. Whether any of it at all could remain unvolatilized is doubtful.

The slides I want to show you have not anything, directly, to do with meteorite craters. They depict the result of some experiments made by Professor S. Mohorovičić, of Zagreb, Yugoslavia, some years ago with a view to getting a

model to compare with the craters of the moon.[1] He caused explosions in a layer of plaster of Paris with potassium chlorate and magnesium powder, setting them off by means of an electric current. The result was this series of what appear to me extraordinarily like lunar craters, and what immediately attracted my attention was the line of material extending radially from the crater rim, these radial streaks corresponding very nicely to the light-coloured streaks of material seen extending from the larger lunar craters and which suggest that these streaks are the result of streams of volcanic ash sent out from the crater. You will notice, too, a slight central elevation such as is also seen on some of the craters. There is also an interesting photograph of the dome of the crater, taken edgeways. I had no idea that these photographs were going to run quite so closely parallel to those shown by Dr. Spencer. It seems that it will be difficult to decide between the volcanic and meteoric theories of the origin of the lunar meteors, since in either case we get an explosion, and the results will be very similar when we are not in a position to find actual meteoric matter.

The PRESIDENT: Dr. Whipple is Director of Kew Observatory Branch of the National Physical Laboratory. He has been particularly interested in the Siberian meteorite, and I think I am right in saying he investigated the air waves at Kew from that particular meteorite.

Dr. F. J. W. WHIPPLE: The investigation which I carried out in connection with the Siberian meteor did not start on my own initiative. It so happened that in 1908 a new instrument, the microbarograph, invented by Mr. W. H. Dines and Sir Napier Shaw for recording variations of atmospheric pressure, had just been brought into use and the records were being deciphered with considerable interest. There was one particular day on which records taken at five different places a considerable distance apart showed almost simultaneous oscillations of pressure, oscillations quite different from any associated with weather changes. Sir Napier Shaw incorporated these observations in a Presidential Address to Section A of the British Association meeting in that year. Little more was said about the observations until, a few years ago, Mr. Cave, who was the owner of one of the microbarographs in question, noticed the coincidence between the date of these records and that mentioned in some popular account of the great meteor in Siberia. Following this clue I made a comparison between the records in the light of the later information.

One of the first things I did was to turn up the records of the International Seismological organization, and I found that certain earthquake records could be attributed to this same phenomenon. In fact the time of the impact of that great meteor, which, in spite of Dr. Spencer's doubts, I still believe it was, could be got within a quarter of a minute from the seismological records. One thing that we learned by comparison of the seismological and aerial records was that we could compare the amount of energy which went into the air and the amount of energy which went into the ground. It appears that about five thousand times as much energy went to make the air waves as went to make the earth waves. Probably a considerable fraction of the original kinetic energy of the meteor was transferred to the air and a very small fraction took the form of seismic waves.

As to the distinction between such craters as have been formed in Siberia and others where meteorites have been found, it seems to me likely that the principal distinction is that between meteorites which are made of iron and those which are of a stony character. It is well known that of the meteorites which are seen to fall and are picked up the great majority prove to be stony meteorites, the proportion being something like ten to one. That indicates that if the big meteorites

[1] The experiments are described by Professor Mohorovičić in the *Arhiv za Hemiju i Farmaciju, Zagreb*, 1928, vol. 2, pp. 66–76.

are divided in about the same proportion as the smaller ones, then there is a very big chance of the Earth being hit by a big stony meteorite. What would happen then is obviously different from what would happen in the case of an iron meteorite. Presumably it is easier to blow a stone to smithereens than to blow a mass of iron to pieces. Therefore it is not surprising that there is sometimes no trace of meteoric matter in the neighbourhood of a crater or set of craters; such may have been produced by a stony meteor. That seems to me a very likely explanation of the contrasts between the two sorts of crater and between the finds in their neighbourhoods. It is interesting to note that the disproportion between the amount of stony matter and the amount of iron which comes down is more or less consistent with the distribution of matter inside the Earth. I believe the metal core of the Earth is something like one-fifth in volume of the matter in the Earth, so that if the body from which meteorites are derived, the mother of meteorites, was composed more or less in the same proportion as the Earth, then we should expect to have five times as much stony matter coming into the atmosphere as iron. The estimates exhibit as much consistency as can be expected in such a field.

The PRESIDENT: Professor Jones is Professor of Geology in the University of Cambridge. I think he has been to Arizona and can tell us something about the crater there.

Professor O. T. JONES: The only reason that I am able to contribute anything at all is that I have seen the Arizona crater, and having seen the others shown in the photographs I think that it is probably as good a test as to the origin of these structures as any of them. For one thing, it has been much better investigated.

The interior of that crater has been bored and the underlying sediments were found to be pulverized to nearly 1000 feet below the plain. Below that level the strata are still undisturbed. These investigations seem to dispose of any idea that the crater is blown up from a depth. Consequently it seems certain that the crater was caused by something which penetrated from above. I happen to know something of what happens when a solid is pressed into a yielding material. If a thick cylinder is pushed into sand the sand is displaced from underneath its end and the sand on each side is arched up for a considerable distance from where the cylinder is pushed in. The arching is not of any great magnitude. In the meteorite crater of Arizona however the rocks were violently blown up close to the edge of the crater, and away from that edge they remained flat.

I am attracted by Dr. Spencer's suggestion that the crater is really due to an explosion. Those investigating the Arizona crater thought, of course, that if they found a meteorite about 14 million tons, or whatever it was, containing quite a large proportion of platinum, their fortunes were all made; they only had to extract the platinum. At the same time, they were a little bothered as to what they would find when they did strike the meteorite. If it was made up of small fragments similar to those found on the surface it would be easy to deal with the material, but if they found a solid mass they could do nothing whatever with it. It would be useless. They could not blow it to pieces as holes drilled in it to receive explosives would simply act as a cannon. To dissolve the mass would also be out of the question. No meteoric material at all was found in the centre, but on the outside they do appear to have met something hard, though nobody has yet proved what it was. Consequently no one has yet definitely proved that there is any meteoric material present underneath the crater.

What I think probably happened is that a meteor penetrated a considerable distance and expended part of its energy in penetrating and pulverizing all the rocks. At some depth in these rocks there is probably a good deal of water, and if the meteor succeeded in burrowing down to nearly 1000 feet below the surface

it might conceivably have generated sufficient steam to blow the rest out. I think that there is no doubt that material forming the crater was blown out because on the surface all round the crater and for a long distance away there are heaps of material, which as seen from the crater rim look like large barrowheads. They are particularly abundant near the crater itself, but occur also for a long distance around.

I suggest that the experiment might be tried of firing a projectile at a high speed into a material such as sand, which is impregnated at some depth with a highly volatile substance such as ether or perhaps liquid air. If a projectile was fired into this so as to penetrate some distance down, craters would be produced very similar to the Arizona crater.

I was not impressed with the one in Estonia. I believe with Dr. Spencer that it is not a crater. There is another large depression in Crater Lake, Oregon, which is a gigantic hole with a lake at the bottom, with steep sides and a great deal of volcanic material around. That is supposed by some to have been blown up, but, if so, one cannot find enough material around to account for the hole. Others say that the top of a volcano comparable with the neighbouring Mount Hood collapsed and thus gave rise to a caldera-like feature.

The PRESIDENT: I believe Mr. Kirkpatrick went to Russia to endeavour to locate the place where the Siberian meteorite fell. I do not think he reached the site, but he saw some of those who had been there.

Mr. KIRKPATRICK: Dr. Spencer's paper is obviously a very valuable summary of what is known concerning meteorite craters. It also contains a good deal of new and original matter based on careful research. Talking things over with him and also reading Dr. Whipple's paper in the *Quarterly Journal of the Royal Meteorological Society* inspired me with the desire to visit the area of the supposed fall of the Siberian meteorite. Accordingly, provided with letters of introduction from Dr. Spencer to his colleagues in Leningrad, I started off last July. Arrived at Leningrad, I called on Professor Fersman, the courteous head of the Mineralogical Department, who at once told me that my plan to visit the Tunguska region was "absolutely impossible." I was reluctant to speak to you this afternoon, knowing I could not contribute any technical information, but my excuse for addressing you is that I saw two persons who had been to the Tunguska site, viz. Dr. Kulik, of Leningrad, and Professor Obruchev, of Irkutsk. Dr. Kulik showed me his specimens, and after about three hours' demonstration I came to the conclusion that he had a very strong case for his meteorite theory. At the same time, several Russian professors have written papers expressing views opposed to this theory. The craters, or depressions, as they call them, happen to be situated in permanently frozen ground and might have arisen, as already suggested, as a result of the alternate freezing and thawing of water in cavities between temporarily and permanently frozen layers of soil. As you have heard, there are several other theories.

However I believe that Dr. Kulik's view is right: that there has been a catastrophic fall of a huge meteorite from space. I do not see how otherwise to account for the radially fallen forest, extending for thousands of square miles, an extraordinary phenomenon. In trying to reach that desolate region I did not of course presume to think that I should be able to add anything to solid scientific investigation, but I thought I might have the luck, if I spent two or three weeks in the neighbourhood looking about in the moss and the trees, to find some bits of the meteorite. For Dr. Kulik told me that shortly after the time of the fall some peasants stated they had found pieces of iron. Most unfortunately no scientific student has ever seen those pieces, so this evidence does not count for much. Then there was the testimony of many people for hundreds of miles

round the area who saw fires and glows in the sky, felt trembling of the ground, and heard loud explosions; besides which there were the blowing down of the trees, and spouting fountains of water for days after the catastrophe, seemingly owing to the formation of artesian wells. The testimony of the peasants is, I think, sound; they could hardly have invented it. Then there is also evidence of air pressure 400 miles away on the Siberian Railway at Kansk; people blown down, and so on. I think scientific men ought to be ready to allow some value to the testimony of unscientific people; and especially they ought to be modest when they remember that for a long time they held entirely wrong views about meteorites. They thought they were bodies belonging to the Earth, and ridiculed the idea that they came from heaven or space. Afterwards scientific men found evidence that the popular theory was right after all.

One thing that impressed me when I was looking through Dr. Kulik's collection was the appearance of the pieces of trees and branches that he brought back from the Tunguska region. He pointed out that they were charred in peculiar ways as if by fire, partly from above, partly laterally, as from some centre, and not by a forest conflagration from below. Dr. Kulik offered to accompany me to the Tunguska, and drew up a plan of the route, viz. by rail from Leningrad *via* Vyatka to Krasnoyarsk, and thence down the Yenisei to the Middle or Stony Tunguska River; we would then be towed up the latter river in a small boat worked by two men, the final stage being completed on horseback. The journey to the craters would take three weeks, and the cost would be 3000 roubles (£450). A few days later Dr. Kulik told me, to my deep regret, that it would not be possible for him to accompany me.

From Leningrad I travelled *via* Moscow to Irkutsk, the capital of Eastern Siberia, on the Angara River. Here I met the distinguished geologist Professor Obruchev, who had seen the Tunguska "depressions" and "didn't think much of them." He informed me that the journey down the Angara to the craters would take about two months, and that problems of food and transport would be difficult for a stranger. Accordingly I went up the Angara to visit the Limnological Station on Lake Baikal, where I was very kindly received by Professor Vereshchagin.

I trust these brief notes on an attempt—even though an unsuccessful one—to reach the Siberian craters may not be considered wholly irrelevant to the present discussion.

The PRESIDENT: I did not know anything about this matter before I came here this afternoon. Now I do. I speak as one of those unscientific people who really do want to know, in plain language, about this class of subject, separating that which is more or less astronomical from that which may be termed geographical. If the Royal Astronomical Society have a meeting at which they will discuss the origin of meteors and, possibly, where they come from, I hope Mr. Hinks will ask me to attend, for I should very much like to approach the subject from the point of view which, as I suggested at the opening of this meeting, was not the one we were going to discuss to-day.

My business now is to thank the lecturer and the speakers for putting forward this obscure subject in a most attractive way, and I can assure you, Dr. Spencer, that I am quite sincere when I say that that you have done. These lectures in the afternoon to the scientists, who already know about the subjects, and also to the unscientific, who frequently do not previously know about them, open up fields of new interest which are very delightful. That has been done this afternoon. I hope in time to come we shall be able to have another lecture on similar lines which will develop the question still further. Please accept, Dr. Spencer, on behalf of this audience and the Society, our sincere thanks for your lecture.

A RECONNAISSANCE OF THE GILF KEBIR BY THE LATE SIR ROBERT CLAYTON EAST CLAYTON

THE untimely death of Sir Robert Clayton deprived the country of yet another young adventurer whose spirit and capacity would have won him many laurels. He had entered the Royal Navy from Dartmouth in 1921. After serving in several of H.M. ships he came to the conclusion that the adventurous life he was looking for could best be found in smaller ships and especially on those stations which do not commend themselves to the majority. As a Sub-Lieutenant he was appointed at his own request to the West African Station in H.M. sloop *Daffodil* (the successor of the *Dwarf* when she was withdrawn for disposal after a generation of service on the "Coast"). On this station Robert Clayton acquired his taste for exploration by making several trips up country.

While serving in home waters, Robert Clayton qualified as a pilot by taking first his A and then his B Licences. On returning to this country in October 1931 from the West African Coast he passed his medical examination for the Naval Air Arm which he intended to enter. He also purchased a second-hand Gipsy I Moth from a brother officer whose treatment of the machine had not been gentle. The machine was known to his friends, and is referred to in his diaries, as *Rupert*.

In the course of that autumn Robert Clayton met a friend at dinner who talked to him of the work which Prince Kemal el Din, Ball, P. A. Clayton, Bagnold, Newbold, and Shaw had been doing in the Libyan Desert. His imagination took fire. Inquiring how he could get into touch with these people he was told that a Hungarian traveller, Count L. E. de Almásy, who had been working for Prince Kemal el Din, was contemplating a journey to a certain part of the Libyan Desert which the Prince, prior to his death in 1932, had been planning to investigate. Robert Clayton promptly asked for and obtained six months' leave on half-pay from the Navy, made contact with Almásy, whom he visited in Hungary in March to discuss plans, and decided forthwith to make the expedition. In the rush of preparations Robert Clayton found time to get married in London. A fortnight later he was on his way to Cairo with his wife and *Rupert*, which he decided to take on the expedition to do reconnaissance flights along and over the Gilf Kebir, the western side of which it was contemplated to explore. *Rupert* needed considerable repair at Heliopolis: he describes the machine as being "mended" or "sewn up with bootlaces." An *amende honorable* to this libel on the R.A.F. took the form of an invitation to Squadron-Leader Penderel, R.A.F., to accompany the expedition, the surveying duties on which fell largely upon Mr. P. A. Clayton, of the Egyptian Survey Department.

Accounts of the expedition have appeared in the press: the report of P. A. Clayton which follows this paper gives an outline of work done. Robert Clayton's death has deprived so many of his friends and the geographical world of the opportunity of hearing his own account, delivered in the racy manner which his shipmates had learnt to associate with him, that a description of the journey, largely in his own words drawn from the notes and diaries which his widow has placed at the writer's disposal, may seem justified. His modesty

and competence had won him esteem. The happy-go-lucky manner he affected concealed real organizing capacity; in the same way did his frivolous and highly coloured speech hide real enthusiasm and courage which his country can ill afford to lose. Much of the language of his diaries is scarcely appropriate for the *Journal*, but something of his personality can nevertheless be guessed from the bowdlerized extract given below.

Robert Clayton's first experience of desert flying over uniform country to ill-marked and scarcely identifiable points began on April 12, when he piloted *Rupert* from Heliopolis *via* Asyut to Kharga to join P. A. Clayton, Penderel, and the cars. "We made a fair landing after finding it terribly difficult to judge height above sand. Time for the 330 miles, 3 hours 30 minutes; secured machine with wings folded by sandbags over the wheels and pegging the tail." On April 13 the cars set out to make dumps of water and petrol, as P. A. Clayton describes in his paper. On the 19th, having returned to Kharga by car with P. A. Clayton and Penderel, Robert Clayton and the latter took *Rupert* to Bir Messaha by air.

"Called at 3.45 by Governor's sentry. Took off well (at 5.40) in spite of overload which made machine tail heavy. Had just turned on to course when I noticed engine cowling, port-side, was open. Penderel tried to reach it by standing up but failed, so we landed again, making perfect landing in still air and good light. Took off finally at 5.50 and flew by compass and landmarks to Camp I, where we landed to show Clayton that we had been there should we not turn up and thus necessitate a search. This was to be our rule whenever flying from point to point. Took straight off from Camp I and flew to Husab el Belgum and then to Black Cone Hill where we had marked a landing-ground. Clayton came out in car on sighting us and laid landing T. After breakfast under machine, and refuelling, took off for Bir Messaha. As there are no landmarks at all within miles of Bir Messaha we followed tracks. Soon after leaving Black Cone we flew over about 30 plover flying N. obviously migrating. Tracks were hardly visible and got worse as the sun got higher. I had to keep my eyes glued to them every second, and even then we lost them once. This was the worst trip I have ever done or ever wish to do. The glare on the sand and difficulty of seeing tracks made my head swim so much that I felt I was going mad, and made me want to dive into the ground to end it all. However we arrived at last and Penderel took over for a few minutes to let me rest my eyes before landing. The glare was so bad that I did not know where the hell I was; so came in on engine till wheels touched. Not too bad a landing considering."

"Had some Chianti to revive me and also to celebrate the opening of the Bir Messaha Country Club. In the afternoon Clayton and I drove to Dune dump where Penderel and Almásy were to follow us. I was so weary and eyesore after the awful trip to Bir Messaha that I couldn't bear the thought of flying again that day. Clayton and I arrived about 17.45, made camp and laid out circle and T. Waited till dark, but no sign of *Rupert*. We had arranged that should the machine not arrive to time the ground party would look out for Verey lights at 20.00, 20.05, 23.00 and 23.05. As a matter of form we climbed the dune behind camp at 20.00 and were surprised to see a light go up from S. It seemed a long way off, as although it was a white one it was very faint. Waited

for the 20.05 one to check our bearing and saw a red light go up which was far brighter than the white. We fortified ourselves and went to pick up the erring aviators."

"Found them on a dune where they had made a flare with petrol in an empty, 'Verey' light cartridge. N.B. This excellent, visible some way, lasts about 30 seconds."

"On 20th April set off in cars about 8.00 for a camp about S. of Gilf Kebir. Visibility was rotten, there being a dust haze. When we stopped for lunch the temperature was 108° with no breeze. Pretty warm."

"After another 120 kms. we reached a suitable place for camping after passing an old camp of Clayton's near a large hill which we called Clayton's Hill. Our camp was under two hills which we called Peter and Paul, as the big one looked like the dome of St. Paul's."

Thursday and Friday, April 21 and 22, were critical days. Robert Clayton's diary, for all its light-heartedness, is a vivid description of how nearly disaster overtook him. Penderel and he were to return to Dune Camp by car to pick up water, food, and petrol, and to fly the aeroplane to St. Paul's Camp. "All went well till we left Sandstone Hill, when Manoufli, who was driving the leading car, tried to cut off a corner. On going to St. Paul's we had gone too far S. so we went E.S.E. to try and pick up the tracks after avoiding the extra distance involved by following the tracks all the way. Unfortunately we crossed the tracks without seeing them. Penderel and I were in the second car discussing the flight back and so also missed the tracks. When within about 20 kms. of where the camp should have been we noticed that Manoufli was still steering E.S.E. Thinking this was only a temporary divergence to avoid bad going we did nothing. After a time we found him still going S. of E. instead of N. and decided to ask him what he was doing. We gathered that he was still going S. to cross our up tracks. Owing to bad haze we had seen no landmarks for some time and were doubtful as to our position. However we spotted a line of dunes some way to the N. After plotting our position on the map from our (very) approximate course . . . we decided it must be the S. end of the first line. Accordingly we went N.E. to try and find our part of the dunes. By this time the wind had risen and a miniature sandstorm had started making visibility worse than ever. To make matters worse the petrol was getting low in the cars and we had only one 4 gallon tin spare."

"After beating N.E. into the wind we saw nothing, so returned to the dunes and camped for the night hoping to have better visibility next day. Before running N. up the dunes one car had run out of petrol so had to be abandoned. When we had decided on our camp, we sent the three Arabs out to have a look round. They came back after an hour or two without having recognized anything. Not cheering! Manoufli remarked in Arabic that 'the arrangement was not good.' Strangely enough we agreed."

". . . Things did not look cheerful. There were two alternatives: one was to go back to Bunnion Hill, having to walk the last 40 or 50 kms., leave ourselves there and send the Arabs on to Sandstone Hill to wait for Clayton and Almásy to come and look for us. The other was to gamble on going N., hoping to find landmarks before the petrol ran out. After much thought we decided on the latter if the Arabs saw nothing next day."

"There being nothing more to do, and to prevent our getting thirsty, we turned in and went to sleep. It was not a pleasant feeling going to bed not knowing where we were. However I slept like a log."

"Woke up feeling empty and thirsty as we had eaten nothing since lunch the day before to prevent thirst. It was a shock to wake up to the fact that we were . . . lost with not much chance of ever getting out of the . . . desert."

"The Arabs were sent off to a small hill 15 (?) or 20 (?) kms. away to see if they could recognize it. P. and I sat down with the map, his notes, a broken ruler, a paper protractor, and sticky oil compass. After assuming that certain mountains seen to the N. were some that appeared on the map we took bearings and plotted ourselves on our map."

"If we were right the hill where we had sent the Arabs was one that had been used for triangulation and had a cairn on it. From there we would be able to get through the dunes in the direction of our camp."

"The Arabs came back about noon saying that there was no cairn on the hill and could recognize nothing."

"There was only the slightest chance of our ever coming out of the business alive, and I must say I found I was a bigger coward than I thought I was. I was really frightened."

"We talked things over and measured out distances on the map and still couldn't put ourselves anywhere else than where we had before. We decided to gamble and chance finding the camp. To rest the Arabs we waited till 15.00 before starting."

"That wait was the worst time I have ever had. I thought of tankards of beer, England, and all the wet things one does think about on these occasions, wondered why I had spent a lot of money to go and die in a desert, and trying to think what to do about last letters, wills, etc. I remembered all the lovely descriptions of people dying of thirst that I have read about and realized that they were mild in comparison. Finally, I thought of all the drinks I have refused, all the wickednesses I might have committed, and again of water. . . . However, I managed to sleep for an hour under the shade of the car and forgot all about it."

"At 15.00 we went back 16 kms. in the car. . . . After collecting the water from the radiator of the other car we set off N. to try and find a way through the dunes. We tried one or two places but failed. We then arrived on a little hill where the petrol finished. On climbing the hill imagine our joy on finding a cairn on top and some known mountains away to the N. We had arrived at the gap in the dunes where we had passed on our way out. The Arabs had got tired before arriving at the hill and had said there was no cairn because they hadn't got near enough to see it. The camp was only 25 kms. away. We packed off the Arabs on foot to collect a tin of petrol for the car and had a drink of water. What a marvellous drink, better than any beer and rather darker in colour tasting of rust, petrol, oil, and Ford car. We then made some tea and had something to eat. Everything looked rosy again, including our lips which were badly cracked."

"After picking up the camp gear, food, etc., we went on to where *Rupert* had been left and made camp. The car was then sent back to pick up petrol and then fetch the other car. . . ."

A group of crater-shaped hills in the Libyan desert, about long. 25° 30′ E., lat. 22° 20′ N.

The unknown wadi north of the Gilf Kebir, about 20 miles long, from the air

"We learnt several lessons from this business: (1) Never trust an Arab guide; (2) always carry enough petrol to get back to your starting-place; (3) keep notes of every journey (it was Penderel's notes that gave us a clue to where we were); (4) take glasses; (5) never forget that the desert is always waiting to hit you below the belt, so don't give it the chance."

On the 24th *Rupert* was flown to St. Paul's Camp, where P. A. Clayton was very relieved to see them. A trip to 'Uweinat for water was made the same day. On the 25th two flights were made. On the 26th from Gilf Kebir Camp Robert Clayton made his first reconnaissance flight over the plateau.

"Penderel and I took off at 8.00 for a recco flight over the Gilf. Having climbed to 1900 we flew N.E. The top of the Gilf was dark sand almost black and seamed with water-ways. In depressions there were mud pans. Cutting up the surface in all directions were deep wadis of red sand with precipitous sides. In a few places there was vegetation, dried up but apparently still growing. On the dark top were several mountain-sheep tracks, very well worn, as otherwise they would not have been visible from the height we were flying (about 600–700 feet above the Gilf). Ahead of us we could see a large area of yellow sand with precipitous slopes down to it from the level of the Gilf. The country looked far too bad for a forced landing, being broken up a very great deal about 60 kms. in, and also impossible of access by rescuing cars, so we decided to return."

"We had thought that we were at the bend of the Gilf where it turns from N. to W. However we found that the real angle was about 10–15 kms. farther S. About 12.30 Clayton and Almásy left for the next corner of the Gilf where it turns N. or E. from W."

"Penderel and I retired to the plane and meditated beneath the wings. We were to start about 17.00 when flying conditions were better and they had made a landing-ground."

"About 14.00 the wind began to rise and a *shebora* (dust haze) came down thick. It went on freshening till at 16.30 we had to hold the wings in gusts. We filled up and took off at about 15.30. The wind was so strong that we took off in about 30 yards, which considering the load carried and the thin air was short."

"Once up we found visibility very bad and the tracks almost invisible. As we were not sure where the others were camping we had to follow the tracks, and hard it was with the sun almost in our eyes. As the ground was a bit hilly and we had to fly about 30 feet it was not much fun keeping one eye on the tracks and the other on the hills."

"I eventually lost the tracks and circled round to pick them up. I found them by some rocks, but they only seemed to circle round and not go on. I then discovered that while looking for the tracks I had been flying over the camp without seeing it. Made a bumpy landing as the wind had risen to about 30 m.p.h."

On the 27th Almásy went to Kufara from the next camp near the corner where the Gilf turns north from a north-westerly trend. No flying was possible that day, which was spent surveying and examining rock drawings and remains in the valleys and gullies which came down from the Gilf plateau. On the following day the weather had improved enough to reconnoitre the Gilf farther

north than had hitherto been attempted. After 20 minutes' flight a "big wadi with trees and grass in it" was seen. "The vegetation increased as we continued and was still visible when we had to turn after 30 minutes." They landed fifty-five minutes after taking off and presumed they had found the long-sought oasis of Zerzura. "The next thing was to find it by car. Unfortunately while we were up there was a haze which obscured the edge of the Gilf." The following days were spent, as P. A. Clayton describes, in trying to locate the debouchée of the wadi—in vain. Their search was blank except for a solitary acacia "with a dove and several woodpeckers in it," a very old track of a solitary camel, and some scanty grass here and there. On the last day "by working to half-pints of petrol and going easy on the water" several more likely debouchées were examined. "As usual there were lots of wadis. We went into one but drew blank." Penderel and P. A. Clayton climbed the scarp and found an old Arab road with cairns. ". . . we . . . drew blank except for one wadi where we found about a dozen trees with about four dead mountain sheep under same. 'Old man Wadi' has beaten us! There is no more juice and it must be the return journey to-morrow. No wonder he is called a lost oasis."

Kharga was reached without incident on May 5. *Rupert* was flown back to England by Robert Clayton with his wife as passenger and relief pilot by way of Sollum, Tobruk, Benghazi, over the sea to Sirt, Tripoli, Tunis, and Sicily—in itself no mean feat for a "bus tied up with bootlaces." Within two months of leaving the Gilf Kebir Robert Clayton contracted a rare form of poliomyelitis and died. According to his wishes, his ashes were scattered from the air over the English Channel by his widow and a brother officer. F. J. R. R.

THE WESTERN SIDE OF THE GILF KEBIR

P. A. CLAYTON, F.G.S.

THE area comprised in the accompanying map was until 1923 entirely unexplored. In that year Hassanein Bey crossed a portion of the district, out of sight of the Gilf, in the course of his famous journey of discovery to the mountains of Arkenu and 'Uweinat.

A line of broken hills, probably the north-east part of the Gilf Kebir plateau, was seen by Mr. W. J. Harding-King from Gebel Bayed in 1910 and 1911, and these hills were more closely approached, but not reached, by Dr. Ball and Lieut. Moore when on a long car-patrol from Mut in 1918. The high southern part of the plateau was sighted for the first time in 1925 by Prince Kemal el Din on his way from Kharga to 'Uweinat, but its size was not realized until 1926, when the Prince's expedition to Sarra passed close to and fixed the eastern escarpment of the plateau. The Bagnold Expedition of 1930 followed the same route along the Gilf Kebir. This name was assigned to it by the Prince, as no local one existed.

During the winter of 1930–31 I carried a triangulation from the geodetic points in the Nile valley right across to 'Uweinat, and up the Darb el 'Arba'in to Kharga; this forms the first portion of the framework of rigorous triangulation which it is hoped will eventually encircle the south-western desert of

Outlying sandstone foothill of the Gilf Kebir in lat. 23° 40′ N.

Typical wadi of the western face of the Gilf Kebir in lat. 23° 59′ N.

Air photograph of "Peter and Paul" peaks, looking west-north-west

Hill near Rocky Camp: typical rock-formation

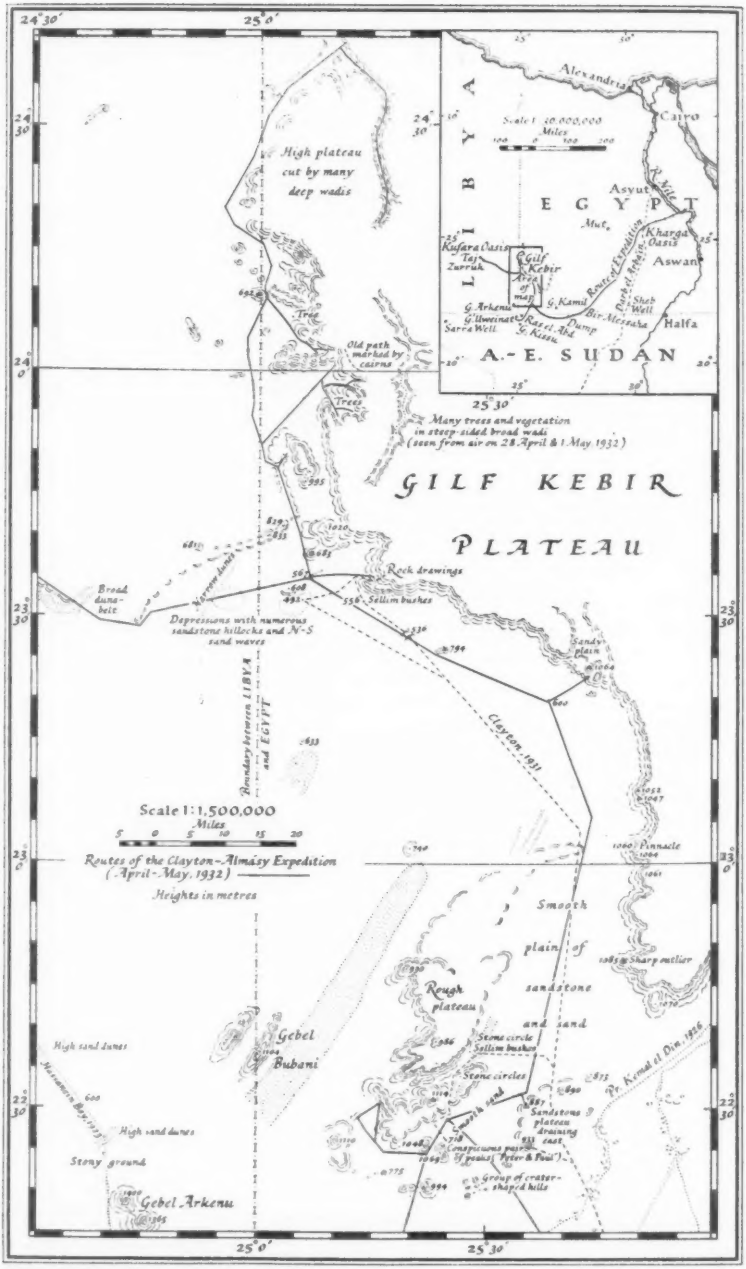
Egypt. West of Gebel Kamil, the triangulation ran across the belt of hilly country lying between Prince Kemal el Din's 1925 route and that used by Mr. Beadnell in 1928, and was connected to Dr. Ball's work round 'Uweinat through the two sharp peaks of Ras el 'Abd (Chunk Hill) and Gebel Kissu. The heights found by triangulation were in all cases lower than those that had been determined barometrically. The points of comparison were Sheb, Bir Messaha, Gebel Kamil and a hill near it, Ras el 'Abd, and Gebel Kissu, and the differences lie between 10 and 16 metres, with a mean of 12 metres. The triangulation heights should be correct within ± 2 metres at Sheb and Messaha, and ± 5 metres near 'Uweinat.

Supplies for the 1931 season were brought by lorry and car from Halfa in practically a straight line to Bir Messaha. From there to 'Uweinat the best route is that discovered by Mr. Beadnell and described by him in the *Geogr. Journ.*, vol. 77, p. 246, except that I found and used a gap through the dunes 75 kms. west-south-west of Bir Messaha—the position of the gap being lat. 21° 58′, long. 27° 15′.

In addition to the triangulation, for which a Zeiss theodolite was used, the area lying within the network of main triangulation points was mapped on a scale of 1 : 250,000. From the triangulation points near 'Uweinat several peaks far to the north-east of that mountain were intersected, as well as a couple of points at the south end of the Gilf, all well over 1000 metres above sea-level. An extensive reconnaissance up the western side of the Gilf had been planned, but practically all the time and supplies earmarked for this purpose had to be used up in rescuing parties of Arabs from Kufara, who had been lost while trying to cross into Egypt and were stranded in mid-desert. There remained however one day available for reconnaissance, with enough petrol and tyres for one car.

On 2 April 1931 I left camp, which was 70 kms. south of the tip of the Gilf, at 4 a.m., with one car and three men, and succeeded in sketching 130 kms. of the western scarp of the plateau in the course of the day's run, which was 421 kms. Astronomical work and wireless were out of the question in the time, so a rapid plane-table traverse was used, with speedometer distances and compass bearings to points of interest.

The route followed lay well out in the sandy plain which lies west of the Gilf; at first a rocky plateau was visible to the west, while on the east the Gilf formed an unbroken wall, impassable for cars or camels, or indeed on foot in most places. After running north for about 80 kms., the escarpment turns west-north-west, and in the corner thus formed a large gap in the upper beds of the scarp was noticed. The scarp runs west-north-west for 60 kms., then turns north again. Opposite this turn a group of *sellim* bushes were met with, growing direct in the sandstone, while to the west a marked depression crowded with sandstone knolls was visible. As camp was 200 kms. away and I had to return that night, I decided not to follow the Gilf farther, but to go up the Wadi debouching from the Gilf opposite the bushes and see if there was any more vegetation. The wadi turned out however to be a barren gorge, filled with rounded boulders and shut in by vertical crags. There were no bushes, but ample evidence of ancient habitation was found: stone grinders, fragments of pottery, and drawings of giraffe and gazelle on a vertical slab of rock at the



Sketch-map by Mr. P. A. Clayton to illustrate the routes of the Clayton–Almásy Expedition

mouth of the wadi. This was the limit of the outward run, and after taking barometric readings for altitude in the depression to the west and sketching the scarp, I returned by the same route, reaching camp about 10 p.m.

The Clayton-Almásy Expedition, 1932

In April 1932 I was privileged to accompany an expedition to the western desert fitted out by the late Sir Robert Clayton East Clayton and Count L. E. de Almásy. Our scheme was to go to the farthest point that I had reached the previous year and discover the course of the scarp north of it, to reconnoitre the top of the plateau from the air, and to examine the district between Gebel Arkenu and the southern tip of the Gilf. In addition to Sir Robert and De Almásy, the party consisted of Squadron-Leader H. W. G. J. Penderel, R.A.F., three Arab car drivers and a cook (veterans of many Desert Survey expeditions), and myself—eight in all. The transport consisted of Sir Robert's 2-seater Gipsy-Moth, which he usually piloted, and three Ford cars which we hired in Kharga, as well as a lorry to dump petrol near Bir Messaha. Neither cars nor aeroplane gave us any trouble other than punctures.

On 13 April 1932 we left Kharga with the cars and lorry, but without the aeroplane, to put out a dump of petrol 530 kms. away (in the dunes 80 kms. west of Bir Messaha), and to mark out landing-grounds. We then returned to Kharga for more petrol and the aeroplane, reaching the dump again on the 19th. Next day we moved on 230 kms. with the three cars and camped near two remarkable peaks which I had visited the year before, and which we always referred to as Peter and Paul. De Almásy, myself, and one man remained here to do some mapping, while the others, after marking out a landing-ground, went back on the 20th along the tracks to the dump for the aeroplane and more petrol. As they did not return until the 24th, we had time for a very useful amount of triangulation and reconnaissance at this camp, though we did not guess the reason for the delay. The tracks had been blotted out by wind and they had gone far to the south, making so long a detour that when after much searching they got back to their route, the petrol ran out and they had the laborious job of getting petrol from the dump to their stranded cars on foot.

North of the Peter and Paul peaks lies an extensive plateau, about 900 metres above sea-level, with a single peak rising to 1114 metres (triangulated the previous year), from the top of which we had a marvellous view in all directions, especially to the west, where a big range of hills lying on the frontier (the 25th meridian), to the north-east of Arkenu, was visible. The inhabitants of Kufara told De Almásy later that they call it Gebel Bubani, and that it is sometimes visible when going from Kufara to Arkenu. The plateau itself is mostly granite, and is nearly cut in two by a large wadi which I had visited the previous year, while between the plateau and Gebel Bubani lies a belt of dunes which looks difficult to cross, but comes to an end in latitude 23°.

The airmen on arrival at camp reported that they had passed over a group of hills of remarkable shape, and Sir Robert flew me over them to get photographs. They are of the cup shape usually associated with volcanic craters, the diameter of the steep wall surrounding them being about 1 km., and the height of the walls about 60 to 70 metres. There are four hills of this distinctive shape, with a fifth which is elongated: all the outer walls are very steep,

and rain-water has in the past cut through the walls to make a single exit from each hill. The district is chiefly gneiss, with granite in places, while the Nubian sandstones, which are several hundred metres thick at 'Uweinat and on the Gilf, seem to be absent. Time did not permit of our visiting them on foot, and all that can be said at present is that they have the appearance from the air of being volcanic in origin.

After obtaining water from 'Uweinat, where we saw no inhabitants—there has been practically no rain for years and the grazing is all withered—we moved north to a camp close under the gap in the Gilf Kebir scarp. An air reconnaissance to the east showed the top of the plateau to be a featureless plain. Cars can be got up the first part of the scarp to the " sandy plain" shown on the map, but it is doubtful whether there is a way right up to the top.

Our next camp was opposite the mouth of the Rock Picture Wadi. We revisited these, but found no more drawings. From this camp we decided to try and send to Kufara for water, as from what we had seen it was judged that there were no serious obstacles on the way. This was outside our original programme, and De Almásy alone possessed a permit to enter Italian territory, so he took the two best cars and the drivers (we only had one car fitted with a compass), while the rest of us mapped and reconnoitred round camp. He accomplished the journey of over 200 kms. to Kufara without incident in seven hours, the first village he reached being Zurruk. From Zurruk he drove to the Italian Headquarters at Taj, where he was most hospitably received and entertained by the Governor, Major Rolle, who was extremely helpful and interested in the expedition. The oasis of Kufara is flourishing under the new régime, and the Italian authorities are assisting many of the inhabitants who left in 1931 to return to their homes in the oasis. The return journey from Kufara, with a week's supply of water, was made next day.

On the day the cars left for Kufara, Sir Robert and Penderel made a reconnaissance flight to the north-north-east over the Gilf, and returned with the news that they had sighted a large wadi with green trees and vegetation along its bed for some 12 kms. As soon as the cars returned from Kufara, the problem arose of how best to get at this wadi; we only had a very rough idea of its position from this first flight over it. We expected it to emerge from the Gilf about 100 kms. north of camp, so decided to search for the mouth and drive up the wadi, if possible.

Leaving the plane well weighted down with sacks of sand, we moved camp to the north, and with Major Rolle's permission kept a few kilometres west of the frontier to avoid the rough going close to the foot of the scarp. Instead of the Gilf getting lower and breaking up, as had been hoped, it was found to continue far to the north, with many wadis, separated by long spurs, running out from the scarp and necessitating long and slow detours between points only a short distance apart in a bee-line. We selected the most likely one of these wadis and drove up it for nearly 40 kms. from its mouth (see map), only to find that it ended in a stony gully, ascent of which on foot took us to the surface of the plateau and demonstrated that it had no connection with the wadi for which we were searching, and of which there was no sign.

We spent altogether nearly three days searching along the scarp, then had to return to the camp where we had left the aeroplane, as supplies of petrol

were running low. These days of search were by no means fruitless, as a large amount of new country was seen and sketched on the map: it is remarkable that many of the imposing wadis draining west from the scarp, filled with rounded boulders and showing every sign of huge quantities of rain-water having rushed down them, only commence at the edge of the scarp, and have no drainage area whatsoever on the plateau. This seems to suggest that they are the remains of an older system of drainage.

On the last day's search, Penderel and I climbed the scarp and found running along the top a path marked out by cairns going in the direction of the wadi, which was not itself in sight across the plateau. This supports the idea that there is no road even for camels up the mouth of the wadi; it may form a steep gorge, but there was no time to follow this path on foot.

On our return to the aeroplane it was decided to use up the whole of our emergency reserve of petrol in two short flights, enabling all four of us to see and record our impressions of the wadi. A careful examination of our notes has made it possible to plot the head of the wadi on the map within probably 3 or 4 kilometres; and it turns out to be much nearer the scarp than the roughly noted duration of the first flight had led us to believe. It could easily be reached on foot from a camp below the scarp near where we climbed to the path.

We consider it certain that this wadi is one of those whose existence and occasional occupation by Arabs has given rise to the legends of the Wadi Zerzura and Wadi 'Abd el Melik. It derives its water from the occasional rainfall on the Gilf Kebir plateau, and not from the source of the artesian water of the oases. At present this district, like 'Uweinat, has had no rains for several years, but water would almost certainly be available in such a wadi for a year or two after rain. There is the axis of a fold running from east to west, just north of the limit of the trees, so it is likely that this fold assists to hold up the water, either in the alluvium of the wadi bed, or in the sandstone itself. We found fresh wild sheep tracks in the district, so it may be that water is to be obtained there even this year. The majority of the trees looked like acacia, but there are also some larger dark green clumps which might be tamarisk; we did not identify any palms.

Though this wadi drains an area of at least 600 square kms. this is only a small fraction of the total area of the Gilf Kebir plateau. I myself saw from the air, about 30 kms. to the east, the edges of a large depression, and until the whole area has been explored it must not be assumed that the main Wadi Zerzura, of which the wadi discovered may be only a part, has been seen.

Kharga was reached without incident on May 5, each car having covered about 4800 kms. in the twenty-three days.

The results of these expeditions have been incorporated in the new International 1/M sheet which the Survey of Egypt expect to publish this autumn. The Gilf fortunately turns out to be over 1000 metres high, and its shape is therefore well brought out by the 1000-metre contour.

THE LIFE OF NANSEN

THE SAGA OF FRIDTJOF NANSEN. By JON SÖRENSEN. Translated from the Norwegian by J. B. C. WATKINS. *London: George Allen and Unwin* 1932. $9\frac{1}{2} \times 6$ *inches;* 372 *pages; illustrations.* 18*s*

NANSEN. By E. E. REYNOLDS. *London: Geoffrey Bles* 1932. $9 \times 5\frac{1}{2}$ *inches;* xii + 274 *pages; illustrations and sketch-maps.* 10*s* 6*d*

NANSEN'S claim to immortality is threefold, for in three respects he stood high above all his contemporaries. He attained supremacy as an Arctic explorer between the ages of twenty-seven and thirty-five, as a patriotic statesman from the age of forty-four onward, and as an international philanthropist on an unprecedented scale from the age of fifty-nine to his death at sixty-nine. His life was a succession of great plans and greater achievements. Even had he failed in his attempts to carry out his three greatest, because almost impossible, undertakings (and he failed in none) he would still have won fame as an able oceanographer, an inspiring professor, a champion in sport, and a true artist.

He was first made the subject of biography when he had just set out on his great adventure in the *Fram* in 1893, defying all the traditions of earlier Arctic voyagers. His friends Brögger and Rolfsen then produced a substantial volume tracing his descent from a line of Arctic adventurers, patriotic politicians, and record-breaking athletes, and recounting his Greenland expedition of 1888 and his biological researches. For some forgotten reason that book was not noticed in this *Journal* except by the title of the English translation.

A few years ago the Oslo publisher Dybwards commissioned Mr. Jon Sörensen, Nansen's friend and comrade in sporting trips, to write a popular sketch as a festival volume to celebrate in the continental fashion the seventieth birthday of the great explorer in 1931. His death in 1930 caused a change of plan, and the result is the standard Norwegian biography 'Fridtjof Nansen's Saga' which appeared in 1931 with a large number of attractive illustrations. An excellent English translation by Mr. J. B. C. Watkins has now appeared, less lavishly illustrated than the original and lacking the remarkable list of awards and decorations conferred upon its subject, but smooth and graceful enough in its diction to rank as English literature. An independent and somewhat shorter Life by Mr. E. E. Reynolds has been published in London. Both volumes, like the Norwegian, bear on the dust-cover the same large portrait of Nansen as an old man, weary but far-seeing, and this may possibly lead to some confusion. Mr. Reynolds's publishers are in error in stating, "This is the first Life of Nansen to appear," as both Brögger's and Sörensen's works preceded it.

Sörensen and Reynolds have adopted identical methods of presentation, a straightforward chronological summary of events. Nearly the same space is devoted by each to Arctic travels, and they are alike also in the space given to the work for the League of Nations. The Norwegian work is naturally fuller with regard to the early years, the part played by Nansen in the politics of his own country, and his personal character and home life. Mr. Reynolds has done his work with painstaking thoroughness and accuracy, but we think he would have been better advised if he had paraphrased the many long passages quoted from the sometimes inelegant translations of Nansen's earlier books. He urges in justification that he made these transcripts "so that his [Nansen's] personality might reveal itself." The revelation is however seen here and there as through a glass darkly. When Nansen wrote in English, as in the Scientific Reports of the *Fram* expedition and his St. Andrews Rectorial Address, his own words are well worth quoting; but his earlier translators often left something to be desired.

Geographers could not expect these books to give any new information about Nansen's work as an explorer. We do however find in Sörensen an explanation of his abrupt cessation of polar work. He had set his heart on leading an expedition to the South Pole and had kept the *Fram* in reserve for that purpose. In 1907 Amundsen came to him and begged him to give the ship for another Arctic drift in which Nansen had no wish to take part. To give up the ship was to renounce all hope of a South Polar journey. There was a dramatic scene on a day when Nansen was called from his high study in the tower of his house at Lysaker to give a final answer to Amundsen waiting in the hall below. On the way down, still irresolute, he met his wife, who exclaimed in grief when she saw his face that she was sure he was going to leave her again. Nansen just looked at her, went down to Amundsen, and told him that he could have the *Fram*. It was a moment of extreme bitterness, for never before had Nansen failed to carry out any great scheme on which he had set his heart. Amundsen sailed in the *Fram* for Cape Horn and Bering Strait, and only when he received the staggering cable from Madeira did Nansen know of the change of plan which had already been decided on. We are not told what he felt, but later he wrote a magnanimous Introduction to Amundsen's book. He vindicated his fellow countryman's expedition in response to a letter from Sir Clements Markham, who had complained that Amundsen's action was not fair play towards Scott (Sörensen, p. 190). Nansen had urged Scott very strongly to take dogs only, and not trust to the doubtful transport by ponies and motor sledges. Amundsen also, it now transpires, had done the same, and we are told that he even offered to give Scott half his own dog-teams. This statement has no relevance to the life of Nansen, but it is of interest in the history of exploration. By the good offices of Consul Bjaarne Aagaard I have been in touch with Mr. Sörensen and Commander Oscar Wisting, the member of Amundsen's party whose name had been given in a Norwegian newspaper as authority for the offer of dogs. Commander Wisting disclaims any knowledge of such an offer which appeared incredible to him as Amundsen could not have spared the dogs. The most probable explanation is that the journalist who originated the story, having heard of Amundsen's gift of dogs to Mawson at Hobart after the expedition to the Pole, confused one British expedition with another and placed the scene of the offer in the Bay of Whales when the *Fram* and *Terra Nova* met there. The frankness and courtesy of Norwegian friends in clearing up the misconception deserve our grateful thanks.

We all felt Nansen to be so close of kin to ourselves that his lapses in his books into what we were tempted to call sentimentality, or at least to think of as morbid introspection, rather jarred upon us. In the purely Norwegian atmosphere of Mr. Sörensen's book however the psychology of the Northern temperament appears throughout as a natural background to the adventurous activity of the early years, and it affords some reason for the amazing devotion to suffering humanity which animated the last decade of his life. To millions of hopeless prisoners of war in Russia, persecuted Armenians, and refugees from all the tyrannies of the Levant, Nansen as he neared the end of his life was the great deliverer. His head appears on the passports issued by the League of Nations to hosts of exiles without a country of their own. Of the magnitude of those labours these books are a revelation to most of us and especially perhaps to those who looked on Nansen as nothing but an explorer and a devotee of scientific research.

It was an impossible task to do justice in one small volume to a life so full of variety and so crowded with great deeds, but Mr. Sörensen has at least succeeded, and it is much, in making Nansen stand out from the snowstorm of the episodes of his life as a man of giant mould, consistent with himself, warmed with the love

of humanity and of all beauty, steadfast in purpose and unshakable in the confidence that his own powers could carry him through whatever labyrinth of natural difficulties or human sin and folly he set himself to master. It has been suggested that Sörensen's book is a eulogy rather than a biography; but it is difficult to see how a short life of such a man could be anything else.

Nansen's friend did well to choose as the title 'The Saga of Fridtjof Nansen,' which must challenge comparison in the mind of every Norwegian reader with the splendid epic of the Fridtjof Saga. The mythical Fridtjof looms through the northern mists as a magnificent being, as strong as ten men, endowed with an immovable will, and the love of all things in his heart. He did prodigious feats of daring by land and sea, overcame the personified forces of Nature and measured his strength against the very gods. Nansen's greatness lay in many spheres rarely brought into contact; but Sörensen has brought sympathy and insight to the baffling task of unifying the life, and his book deserves in every part of the world the high esteem which it has won in Norway.

I knew Nansen as a young man when I also was young. I collaborated with him in international scientific research on the sea during our years of maturity, and even when we were farthest apart in our pursuits as years increased, his overwhelming preoccupations never interfered with his prompt response in correspondence or dimmed the cordiality of our occasional meetings. It has been my lot to read many biographies of old friends with whom I had worked, whose ambitions I shared and whose careers I had followed with warm personal regard; but I cannot recall any which gives so true a portrait in so few pages as 'The Saga of Fridtjof Nansen.'

HUGH ROBERT MILL

REVIEWS

EUROPE

THE BRITISH ISLES. By E. D. LABORDE. *Cambridge: University Press* 1932. 8 × 5 *inches;* xiv + 324 *pages; illustrations and maps.* 3*s* 6*d* [Also published as Book 7 of "School Geographies," at same price.]

This book is stated to be suitable for senior schools. If the term "senior schools" refers to the new upper departments of elementary schools, then it is much too difficult owing to the fact that the best pupils from the junior departments have probably all gone to secondary or central schools: the residue is often very poor material. The book should find a place amongst pupils over fourteen. It is perhaps the best elementary text-book on the British Isles that deals with them regionally in some detail. The section on the relief would be of great value to matriculation students: it is a very simple lucid account of the geological history of our land forms. The book has a large number of excellent photographs, maps, and diagrams, many of which are new to books of this type. Teachers in secondary and central schools would do well to examine Dr. Laborde's pleasant and effective aid to the study of the British Isles, and to find a place for it in the school reference library even if they do not adopt it as a text-book. E. Y.

L'AUVERGNE. By PHILIPPE ARBOS. (Collection Armand Colin. No. 147. Section de Géographie.) *Paris: Armand Colin* 1932. 7 × 4½ *inches;* 222 *pages; sketch-maps.* 10.50 *fr*

This is a study of the volcanic portion of the Central Massif, covered roughly by the departments of Cantal and Puy de Dôme and the arrondissement of Brioude, together with the crystalline uplands of the Forez and the Margeride. A certain unity is given to the area by the drainage system of the upper and middle Allier, whose waters converge on the tectonic basin of the Limagne. True, the districts described as la Chataîgneraie and l'Artense, as well as the western slopes of the Cantal Massif, drain to the Dordogne; but, as the author admits, these areas have relations rather with the Midi and with Aquitaine than with the rest of Auvergne, and at most form a kind of march zone.

The book is divided into two parts, of which the first treats of general characteristics, while the second presents regional studies. The chapter on structure and relief is very brief, and of necessity superficial, and its content is not greatly developed in the regional chapters. In the dozen pages devoted to climate there are some interesting references to local winds and their significance to the peasant farmer. In both sections the pastoral industry is rightly emphasized. Otherwise the economic section is slight and somewhat lacking in precision; but there is a useful map showing the extent of hydro-electric development. A chapter on population and habitat contains interesting information on seasonal migration and emigration, and on types of dwelling.

The regional studies are grouped under Eastern Massifs and plateaux, where the deserted Margeride and the forested slopes and the high moorland pastures of the Forez contrast with the mixed agricultural and forest land of the lower Livradois; the Western Plateaux, or march-lands, which appear to be but vaguely attached to the major region; the Monts d'Auvergne proper, comprising the Cantal and the Monts Dore with the level volcanic plateau of Cézalier; and, finally the Plains and Basins of the Allier. One feels that these last two sections might have been accorded a larger proportion of the book (they occupy less than a third), as being the essential Auvergne. There is something a little artificial, and

therefore unsatisfying, in the sharp delimitation of the region to the north. The situation of Auvergne, midway between the industrial regions of the Loire and the Centre, has surely some significance: in the modern industrial development of Clermont Ferrand, for example.

On the whole the author appears to have carried out the purpose of this handy edition: "de vulgariser sans abaisser," and has added a useful and readable item to our geographical library of regional studies. H. O.

IN FINNISH WATERS: from Estonia to Sweden. By K. ADLARD COLES. *London: Edward Arnold & Co.* 1932. 7½×5 *inches;* 190 *pages; illustrations and charts.* 7*s* 6*d*

Most of us have looked at a map of the Baltic at one time or another, and nearly all who have done so must have had a longing to explore the dense archipelago of islands which lie between the south of Finland and Sweden. The author of this book has yielded to this temptation and gives us a light but interesting account of a cruise of exploration in the Finnish yacht *Sjöfröken*, which he chartered in Abo. The author safely navigated through the thousands of rocks and islets, the tortuous channels many of which are uncharted, and even got in and out of three zones of "abnormal magnetic conditions" without any damage to himself, his wife, or his vessel. To any one thinking of sailing in this part of the world, even if no farther than Stockholm, this book should prove valuable in its description of the country and the dangers to navigation, and in its advice of how to avoid these dangers. It has an index, and the particular good feature of track charts printed in that part of the text to which they apply. A. C.

HERE ARE STONES: an account of a journey to the Aran Islands. By IAN DALL. *London: Desmond Harmsworth* 1931. 7½×5 *inches;* vi+200 *pages; illustrations and sketch-maps.* 6*s*

Ian Dall, a pseudonym which conceals a Scottish artist of distinction, visited the Aran Islands, off the west coast of Ireland, in search of a civilization deeper and simpler than that of the modern world. Whether he can be said to have found it will depend on the taste of individual readers; but he has succeeded in capturing the strange atmosphere of these lonely islets and in understanding the courageous but mystic temperament of the inhabitants. Since the islands are masses of limestone, with no trees and little vegetation except in the valleys and sheltered rifts, the title of the book symbolizes both the hard life of the people and the unchanging nature of their culture, which is almost as old as the prehistoric stone forts that crown every cliff. Ian Dall has been influenced by Synge, but his understanding is kindlier and he sees with the eye of an artist rather than with that of a dramatist. This is in no sense a geographical work. It is a book full of delicate observation and imaginative suggestion, written in a style that seems—but is not—almost as simple as its matter. E. L.

ASIA

JEHOL: CITY OF EMPERORS. By SVEN HEDIN. Translated from the Swedish by E. G. NASH. *London: Kegan Paul, Trench, Trubner & Co.* 1932. 10×6 *inches;* xiv+278 *pages; illustrations and plan.* 18*s*

This book consists of two parts: chapters I, II, IV, and V give a narrative of a journey from Peking to Jehol and of visits to various monasteries and temples at the latter place, while the other chapters essay imaginative reconstructions of historical episodes connected with it. The book is illustrated by sixty-two

photographs taken by Dr. Gösta Montell, and these are by far the most valuable part of it, for they provide a satisfactory pictorial record of a group of buildings which seem doomed to speedy decay and ruin unless something is done very soon to preserve them. It is good news that the fine Golden Pavilion of the Jehol Potala is to be provided with copies which may well outlive it: Mr. Vincent Bendix, of Chicago, has created a fund for the erection of two replicas, one in Chicago and the other in Stockholm, and this book is itself a by-product of the expedition sent to make the necessary study of the original.

Jehol is in the public eye at the present time as a bone of contention between Manchukuo and Nationalist China. Architecturally it is peculiarly interesting for its blending of Chinese and Tibetan styles, reflecting the ecclesiastical policy of the Manchu Emperor Ch'ien-lung. The praise bestowed by Dr. Hedin on some of the buildings is not misplaced, but architectural criticism in these pages makes way for sentimental rhapsodies which can only weary the intelligent reader. The same sentimentality of approach renders the historical sections of the book all but worthless. The author had a number of Chinese documents bearing on Jehol specially translated by Mr. T. K. Koo of the National Library in Peking, and several of these documents as quoted are extremely interesting, but Dr. Hedin makes no good use of this historical material. He himself admits that "fantasy has a place" in his work, though he has "preferred to keep to the solid ground of truth"; if so, his instinct for romance seems to have overridden his preference. The account of the migration of the Torgot in 1771 is preposterous; the movement is represented as a unique event and a reckless adventure in spite of the fact that the same horde had made a longer migration less than two centuries previously and that the hardships they endured were but the commonplaces of wars and folk-wanderings in the steppes. It is a pity that the author's talent for journalism has prevented him from writing the straightforward history of Jehol and its monuments which would have been worthy of Dr. Montell's excellent photographs. G. F. H.

INDIAN CASTE CUSTOMS. By L. S. S. O'MALLEY. *Cambridge: University Press* 1932. $7\frac{1}{2} \times 5$ *inches;* x+190 *pages.* 6*s*

It is no easy thing to deal fairly by a social system which is described as "the steel frame binding together the many beliefs massed together in Hinduism" (p. 19), but Mr. O'Malley has tackled his task with personal knowledge, firmness, and a sense of proportion. Two things must be kept in mind. First, there is the polity known as the caste system, which rests on what must be called a philosophy; secondly, there are the units—castes—whose interdependence and co-activity constitute the machinery of that system. The parts must not be isolated from the organic whole. The system is based on a general plan, recognizable throughout India (p. 21). There are local variations, due to ethnic differences and to historical and geographical conditions, in the details of the relations between the units, which themselves disclose evidence of varied origins. The system works well or ill, according to the spirit in which it is worked. The evils of caste are patent (p. 179), but its great "value lies in inculcating and maintaining principles of self-restraint" (p. 177).

The chapters on Caste Government, Penalties, and Marriage show it to be a system which exercises close control over the members of the community, generally attempts to do justice, and keeps up the moral tone (see p. 199). It fosters a sense of corporate unity and loyalty. The principle of the Mandate system of strengthening such institutions ought, in the author's view, to be applied and extended, not destroyed by imitations of a political system derived from and congruous with very different conditions. Special interest attaches to

the chapter on the Untouchables, or Exterior castes, as they are now called, whose ranks are constantly recruited from tribal communities, an indication of a movement which is continually taking place. The chapter on modern tendencies is valuable. The conservative element in India is strong: how strong is not easy to say, but it is well to note that (p. 175) there is no general revolt against the system, for it allows, even encourages, lower groups to enhance their social prestige by moving to conformity with the practice of higher castes on whom therefore rests a great responsibility.

This little book should be read by every British officer serving among Indians and by all those who respect and would strengthen any institution which stimulates the spirit of corporate unity and does good work as the guardian of morality. The caste system is likely to endure and could and should be made the keystone of political developments. T. C. H.

VIEWS OF TYPICAL DESERT SCENERY IN EGYPT, prepared by the Geological Survey of Egypt and presented to the International Geographical Congress at Paris, 1931 by command of His Majesty King Fouad I. *Giza: Survey of Egypt* 1931. 14½ × 20 *inches;* xii *pages and* 34 *plates.*

Our knowledge of the Egyptian deserts has been very much increased during the last decade by expeditions undertaken by T.S.H. Prince Omar Toussoun and the late Prince Kemal el Din, and the great interest of the Royal Family in the desert is now further expressed by the publication, under the direction of the Surveyor-General, of the present album of photographs of typical desert scenery, prepared by command of His Majesty King Fouad I for the Geographical Congress 1931.

Many of the photographs have been published previously in various departmental reports. The selection has been made by the past and present Directors of the Geological Survey, who contribute an admirable and adequate introduction to the series of views. Not so long ago photographs for preparation as illustrations had to be sent to Europe, but a high standard of reproduction has now been attained in the Reproduction Office of the Survey of Egypt, under Mr. Rowntree.

Considering the difficulty of obtaining satisfactory photographs of desert landscapes in the glare of the Egyptian sun, and of avoiding the unpleasing effects of high lights and deep shadows when exposures are made in early morning or late evening, the more purely desert illustrations in the album convey an extremely good impression of some of the most arid tracts in the world.

H. J. L. B.

AFRICA

REIZEN IN ZUID-AFRIKA IN DE HOLLANDSE TIJD. Edited by E. C. Godée Molsbergen. Vierde Deel. Tochten in het Kafferland, 1776–1805. (Werken uitgegeven door de Linschoten-Vereeniging. XXXVI.) *'s-Gravenhage: Martinus Nijhoff* 1932. 10 × 6½ *inches;* xxxii + 366 *pages; illustrations and map*

This volume completes the series of 'Travels in South Africa in the Dutch Period (1652–1805)' so capably edited for the Linschoten-Vereeniging by Dr. E. C. Godée Molsbergen. The first two volumes, both now out of print, dealt with journeys to the north, the third with journeys to the east, including voyages along the coast. This final volume continues the third but is confined to inland expeditions, viz. those of Hendrik Swellengrebel (1776), Governor Van Plettenberg (1778), Governor Janssens (1803), and Commissary-General De Mist (1803–4).

In addition there are two special accounts of South African native races: one of the Kaffirs, written in German by F. von W., now identified for the first time as Franz Carl Philipp, Freiherr von Winckelmann, and another of the Cape Hottentots, translated into Dutch by J. W. G. van Oordt from the Latin of Jan Willem de Grevenbroeck, who was secretary to the Council from 1684 to 1694.

The journal of Swellengrebel's expedition was kept by Pieter Cloeten. The party left Hex River on 21 September 1776, crossed the Karroo, and reached the Great Fish River on October 25. Friendly contact with a Kaffir chief, Jeramba, was established two days later, and a few pages of the journal are devoted to a description of the natives. After a vain attempt to proceed farther east, the expedition returned to Fort Good Hope by a more southerly route. In contrast with the pioneer expeditions of the previous century, Swellengrebel's party was in contact with Dutch settlers almost the whole way. One of these, Jacob Kock, who had a substantial homestead on the Groote Zeekoe River, thought that there would be a good anchorage for ships west of the mouth of the Zwartkop River. This would appear to be the site of Port Elizabeth. Van Plettenberg's journey of 1778 was undertaken in response to an appeal from settlers in the east and north-east for better protection against marauding natives and for the establishment of a local court and a church. The governor crossed the Karroo between Matjesfontein and Aberdeen and reached the neighbourhood of Colesberg, where he erected a stone beacon. Returning by the same route to the Graaf Reinet district he then made a detour to the Great Fish River, where a treaty was made with certain Kaffir chiefs, the river being fixed as the boundary of the colony. The return was made roughly along the line followed by Swellengrebel.

With Janssens and De Mist a new period begins, for their journeys were not so much exploring and trading expeditions as official tours of inspection. The first brief English occupation of the colony had just terminated, and the newly appointed Dutch officials were anxious to pick up the threads of government again and to come to terms with the more powerful and truculent Kaffir chiefs on the eastern frontier. While not devoid of ethnological, zoological, and other scientific interest the journals of Janssens and De Mist are concerned rather with the economic welfare and political security of the settlers than with the manners and customs of native races.

The book is embellished with thirteen plates, including one of Bushman drawings, and a map, which would have been more useful had it covered a smaller area on a larger scale, with more precise indications of the routes followed. The appendices include additional observations on the Kaffirs, derived from Lichtenstein, who accompanied De Mist and kept the journal, a genealogical table of Kaffir chiefs, a few historical notes, and a short account of a journey to Saldanha Bay in 1804. "Boscoe" for "Roscoe" on p. xxx is the only obvious misprint.

G. W.

PAGAN TRIBES OF THE NILOTIC SUDAN. By C. G. SELIGMAN and BRENDA Z. SELIGMAN. [Vol. II of] 'The Ethnology of Africa.' Edited by J. H. DRIBERG and I. SCHAPERA. *London: George Routledge & Sons* 1932. 10×6 *inches;* xxiv+506 *pages; illustrations and map.* 42*s*

This book is one of the series on The Ethnology of Africa edited by Mr. J. H. Driberg and Dr. Schapera, and deals with the tribes of an area which is of special interest to Great Britain. For the serious student of social anthropology a book by the Seligmans is always an event of great importance. He expects, and finds, sober unsensational science, good material presented with sanity and moderation, reliable facts gathered with intelligence and insight, and based on personal knowledge reinforced by a just use and cordial appreciation of the work

of others. Full use has here been made of the important work of the senior editor of the series, Mr. J. H. Driberg, "the only man who has any knowledge of the tribes inhabiting the remote south-eastern border of the Sudan," and of the published and as yet unpublished knowledge of Professor Evans-Pritchard with regard to the Azande and the tribes of the south-west Bahr el Ghazal. Many other works have been consulted and cited. such as those by Archdeacon Shaw, Mr. G. O. Whitehead, and Mr. Ernest Haddon.

Sir James Currie, on the advice of the late Dr. Hogarth, induced the Sudan Government to invite the authors to undertake the ethnological survey of this area and, through the Education Department, to provide funds for the purpose. In an admirable foreword Sir Harold MacMichael, the distinguished author of the 'History of the Arabs in the Sudan' (now Chief Secretary to the Sudan Government), lays stress on the geographical features which here, as elsewhere, play so large a part in shaping the social and the economic order—the great mountains, the impenetrable marshes, the dense forests, the lack of communications, the diversity of language. He would have us remember "the fundamental similarity of outlook of white man and black upon major issues," and while allowing that long experience counts, insists that "the great value of scientific anthropology for the administration lies in the fact that this point (understanding the native) can be pushed farther afield" by its help. The administration needs anthropology and in its turn anthropology has gained much of abiding value by the association with it of administrators who see and know things from a special angle. That things are often withheld from the administrator which the anthropologist may find if he has gained the confidence of the people and is not in search of a stunt, is obvious, as is the fact that missionary records are apt to be even unintentionally coloured by their special attitudes. All points of view, the anthropologist's, the administrator's, the missionary's, are valuable and helpful to the purpose of science.

In all sorts of matters, succession, inheritance, land tenure, marriage rules, economic activities, the task of the administrator is lightened and simplified by anthropological knowledge. Above all there is the difficult matter of magic. The authors were told that "the Government understood nothing, nothing about magic." We owe to Professor Evans-Pritchard a clear account of how Zande public opinion regards it, condemns black magic as dangerous and destructive, and gives it a separate name; while it fosters and approves as good magic that which protects and preserves and brings prosperity to the society. To deny the existence of magic is foolish: the facts are there. To forbid it is impossible. Is it possible to control it through public opinion, which is a force of tremendous power in the lower culture where the educational processes produce a high sensitivity to public feeling? Is there a physical, a racial, foundation for the undoubted fact that "the savage is more suggestible than we are, and that autohypnosis is far more common and far more easily induced than among ourselves"? It may be that belief in "the omnipotence of thought" lies at the base of all magic. How are the young sensitized to, and how are they taught, this belief? Regard must be had to the educational processes at work in these simpler societies and to the ideas, vague and general as they often are, which are so stamped into their minds as to become the mechanism or structure of all later mental activity.

On the problems of culture contact and the capacity of the African to adapt himself to the changes inevitable on the expansion of European activities, much has to be said, and material such as is presented here with such care and skill will be invaluable for the statesman who has the task of looking ahead and planning a new order.

BIG GAME SHOOTING IN AFRICA. Edited by Major H. C. MAYDON. (The Lonsdale Library. Vol. XIV.) *London: Seeley, Service & Co.* 1932. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* 446 *pages; illustrations and map.* 25*s*

The fourteenth volume of the Lonsdale Library is a comprehensive account of wild-game shooting in Africa, designed to guide and assist the sportsman. Major Maydon and his fine team of twenty-one collaborators have covered the whole of this extensive field in a thorough and eminently authoritative manner. The book is very practical and full of information. Any question that the sportsman is likely to put to it on such subjects as equipment, camp management, medical requirements, hunting, stalking, the preservation of trophies, pattern of weapon, and so on is almost certain to be answered both with accuracy and in detail. Much attention has been given to dangerous game and the several problems associated with them. The various territories—the Sudan, Somaliland, Kenya, Tanganyika, Nyasaland, Rhodesia, etc.—are each considered by an authoritative author, who not only discusses the nature of its game, but often supplies hints which specially concern his district. Though essentially practical, the book also makes good reading, for it contains many hunting episodes, notes on the habits of the animals, scattered descriptions on the nature of the country, and some account of the bird life. An appendix contains a statement of the game laws of the territories, the necessity for which is clear to any one who compares the wild life as it was in the days of the old hunters with the dwindling remnant that exists to-day. The authors are alive to the importance of such legislation and never fail to preach the canons of good sport. Their book is likely to be a standard work which hunters will look to for guidance and instruction. R. W. G. H.

A REPORT ON THE FISHERIES OF UGANDA, investigated by the Cambridge Expedition to the East African Lakes, 1930–31. By E. B. WORTHINGTON. Published on behalf of the Government of Uganda Protectorate by the Crown Agents for the Colonies 1932. $10 \times 6\frac{1}{2}$ *inches;* 88 *pages; illustrations and sketch-maps.* 7*s* 6*d*

The present is the third of a series of reports on the fisheries of Central Africa, the first two having dealt with Lake Victoria and with Lakes Kioga and Albert. The expenses of the earlier investigations were partially met by the Governments concerned, while the results in the present volume were by-products of purely scientific investigations, accounts of which have already been published in the *Journal* (vol. 79, p. 275, 1932). Lakes Edward and George joined by the Kazinga Channel, Lake Bunyoni, Lakes Nakavali, Kachira, and Kijanebalola, and Lake Nabugabo, are herein considered in respect to the development of their fish populations, so that the best use may be made of these sheets of water as the country becomes more densely populated. Lake Rudolf is also well known owing to our author's researches, but, being situated in a desert region, there is as yet no question of economic fisheries.

Lake Edward proved to have a trough of 117 metres' depth close to the steep Congo escarpment, the floor sloping gradually to the south-eastern shore. To the east the Kazinga, a channel 30 miles long, connects with Lake George; the depth of these parts does not exceed 5 metres, the Channel having a certain surge of waters but no continuous current. The water of Lake Edward differs from that of Lake George in being much less turbid, far more alkaline, and less rich in phosphates. It has a temporary surface-heating up to 26·6° C. with 25·8° to 40 metres in depth. From this to 60 metres the temperature drops to 24·8° C., producing a marked thermocline, and remains constant to the bottom; this lower water being almost devoid of oxygen and smelling strongly of sulphuretted hydrogen, has few organisms, only such as are able to penetrate

its depths by carrying their own oxygen supply. The fish number forty-four species, of which only fourteen were previously known. The endemics numbered twenty-six species, but the fish fauna as a whole proved to be related to that of Lakes Victoria and Kioga, rather than to that of the Nile and Lake Albert. The absence of crocodiles from these lakes is of importance, especially to net fishermen, and the reasons for this are discussed; the suggestion, on the evidence of bone beds, is made that the crocodiles were killed out in a period of desiccation and are unable now to pass up the Semliki rapids or through the jungle that fringes the same.

Of the other lakes Nakavali is one of a series of five shallow lakes which form about 60 square miles of water and swamp connections between Lakes Edward and Victoria. Nabugabo is a part of Lake Victoria that has been completely cut off by the growth of a sandspit; why it has no crocodiles is a mystery. Lake Bunyoni at 6474 feet is a valley dammed quite recently by a lava flow and is 39 metres deep. It has a temperature of only 20° C., very slightly decreasing in the subsurface waters, and is slightly alkaline. Until the Little Catfish was introduced in 1917, fish were entirely absent, but there are crabs, prawns, the smaller crustacean orders, some molluscs, and insect larvae of many kinds. The only vertebrates are frogs, otters, and water birds. Water plants are plentiful and there are swamps of reeds and papyrus. The proposed introduction of the local "carp" (*Tilapia*) and subsequently of Black Bass should not materially interfere with the present fauna. In Uganda there are also innumerable small lakes which occupy craters of extinct volcanoes, a few of which were visited. Most have their own closed drainage basins and some are fed by saltwater springs, the waters of Katwe and Kisenyi being almost saturated solutions of salt. Perhaps more important information will be obtained from such small water areas as to the ecology and the modes of dispersal of freshwater organisms than from the larger lakes, which had to be studied as a necessary preliminary and which may now be regarded as relatively well known.

The reports on all these African lakes make us conscious of the great importance to fishery research of proper geographical as well as of biological studies, the history of the formation of the lakes, the importance of pluvial and interpluvial periods, the prevalence of the building out of spits and bars by regular wave action as giving rooting places for plants and as forming lagoons that may be cut off as secondary lakes, and the questions of drainage and evaporation. There is the chemical side, the amount and nature of the salts in the waters and the amount of alkalinity, for on these depend the quantity of bottom living and floating plant life that is the basal food for all animals. All these matters are considered for each lake and in addition each fish is discussed in respect to its quality, its habitat in the lake, its food, its breeding habits, and its potential or actual enemies. Then there are broader questions relating to the fishing population if such exists and to the transport and curing of the fish. There may be, as the author believes, large untouched and potential supplies of fish to be obtained from each of the larger lakes, if certain recommendations are adopted, but clearly active development will be difficult in many parts on account of the restrictive sleeping-sickness regulations operative in many places. Into many lakes it may be desirable and necessary to introduce fish for food or even sport, but "it is strongly urged that no attempt should be made with regard to such possible introductions until the lakes in question have been submitted to an exhaustive examination by a competent authority." The author is our most competent authority. J. S. G.

NORTH AMERICA

NARRATIVES OF THE TRANS-MISSISSIPPI FRONTIER. [General Editor: CARL L. CANNON.] *Princeton, N.J.: University Press* (*London: Humphrey Milford*) 1932. Route across the Rocky Mountains. By OVERTON JOHNSON and WM. H. WINTER. Edited by CARL L. CANNON. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xx+200 *pages; illustrations.* 17*s* ($3). The Past and Present of the Pike's Peak Gold Regions. By HENRY VILLARD. Edited by LEROY R. HAFEN. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xvi+186 *pages; illustrations and maps.* 14*s* 6*d* ($2.50). A Journal of the Santa Fé Expedition under Colonel Doniphan. By JACOB S. ROBINSON. Edited by CARL L. CANNON. $7\frac{1}{2} \times 4\frac{1}{2}$ *inches;* xx+96 *pages; illustrations and map.* 11*s* ($2). The Emigrants' Guide to California. By JOSEPH E. WARE. Edited by JOHN CAUGHEY. 8×5 *inches;* xxiv+64 *pages; illustrations and map.* 11*s* ($2)

The westward movement of the American people from the Atlantic to the Pacific is, for the geographer, the most interesting subject in American history. While the crossing of the Appalachians and the advance to the Mississippi have frequently been described in English books on America, the expansion from the Mississippi to the Pacific, which took place during the first half of the nineteenth century, has been generally neglected by English writers, in spite of, or perhaps because of, the vast amount of literature available on the subject. The gradual advance of the American frontier has however been brilliantly described by the American historians F. J. Turner and F. L. Paxson. A large number of diaries and reports made by early western travellers have been edited and reprinted in America, and the Arthur H. Clark Publishing Company have been especially enterprising in this work. One of their publications, edited by R. G. Thwaites, is a series, in thirty-two volumes, of annotated reprints of works of travel, printed under the general title of 'Early Western Travels, 1748–1846.' Nevertheless H. R. Wagner's invaluable bibliography entitled 'The Plains and the Rockies. A Bibliography of original narratives of travels and adventure, 1800–1865,' shows that, in spite of the avalanche of republication, there are still a number of important rare books, which English students cannot obtain. For this reason the Princeton University Press is to be congratulated on publishing a new series of 'Narratives of the Trans-Mississippi Frontier, Reprints of western Americana.' None of the first four volumes of this series has been previously republished, and the original of one of them fetches from 300 to 500 dollars at an auction.

During the last century the face of America completely changed; the development of mining, the construction of railways, the rapid growth of towns entirely altered the old America. For the student of geography, works such as those now reprinted in this series are of immense value in helping him not only to reconstruct a picture of the geography of the past, but also to understand the geography of the present.

Johnson and Winter's book, 'Route Across the Rocky Mountains,' was printed on a newspaper press at Lafayette, Indiana, in 1846. Its purpose was to serve as a guide-book for prospective emigrants along the Oregon trail, and it describes the climate and economic possibilities of Oregon and the dangers of the journey. Johnson and Winter took part in the emigration of 1843, which was known as the Great Migration, because 200 families accomplished the journey in 121 wagons. Johnson and Winter were of the opinion that the Prairies and Rocky Mountain region could never support a large population. All explorers from Pike in 1806 and Long in 1820 regarded the area as the Great American Desert. Professor Webb, in his recent book, 'The Great Plains,' has shown that persons who were accustomed to the forested environment of the eastern

states would naturally hold this unfavourable view of the western area. Johnson and Winter not only described Oregon, still jointly occupied by Great Britain and the United States, but also wrote accounts of California, then a province of Mexico, and explained the routes from Oregon southwards into California. The book is written in a lively style and contains amusing descriptions of life in California, while it is interesting to note that the province already produced a large quantity of fruit, such as grapes, peaches, pears, and apples.

The annexation of Texas by the United States in 1845 precipitated a war with Mexico. One of the expeditions of the war was General Kearny's march to Santa Fé and San Diego. This campaign, in which a regiment of Missouri Mounted Volunteers led by Colonel Doniphan played a prominent part, has received considerable attention from American historians, partly because of its military importance, but also because of the extraordinary hardships endured. Many accounts of this expedition have been printed, but Jacob S. Robinson's 'Journal of the Santa Fé Expedition under Colonel Doniphan' has not been previously republished. J. S. Robinson, a native of New Hampshire, who happened to be in St. Louis when the regiment was being raised, enlisted mainly because he was curious to see the west. It is said that the campaign was important because "the claim of the United States to the south-western States of New Mexico, Arizona, and California, concluded by the Gadsden purchase, was based upon the conquest of those territories by Kearny and Doniphan." The expedition left Fort Leavenworth in June 1846, and following the line of the Santa Fé trail, reached Santa Fé in fifty-seven days. After the capture of Santa Fé the regiment defeated the Mexicans at El Paso, and having marched to Chihuahua, eventually returned to New Orleans in June 1847. During the year the expedition had marched a distance of 3500 miles, a remarkable achievement. Robinson was not particularly interested in the military side of the campaign and states that he "looks with more satisfaction upon the scenery of the new country through which he passes, than upon the exploits of the battlefield." For this reason, the journal of this observant soldier is of use to geographers, and the descriptions of the Santa Fé trail, of life in Mexico, and especially of the Navajo Indians, are of great interest.

The westward movement was accelerated by the annexation of California and other parts of Mexico, which followed the conclusion of the Mexican war in 1848, but the discovery of gold in the Sacramento Valley in the same year was the real cause of large-scale emigration. 'The Emigrants' Guide to California,' by J. E. Ware, published in 1849, was the first practical guide-book written to assist those seeking the goldfields, and Wagner states that it is one of the twenty rarest volumes of Californiana. The book recounts the advantages and disadvantages of the different routes to the goldfields. It was possible to make the journey by sea from New England round the Horn in about six to nine months as a cost of about 600 dollars. An alternative route was to go by sea to Panama, travel by land across the unhealthy isthmus, and risk a long wait for another vessel on the Pacific side. The shortest route was to cross the Plains from Independence, Missouri, a journey which lasted about one hundred days and might cost less than 60 dollars per person, if carried out by a combined party. Americans had found their way into California in small numbers before the gold rush; they had followed the Oregon trail as far as Fort Hall and then crossed the desert and the Sierra Nevada by a number of different routes. As far as Fort Hall, Joel Palmer's 'Journal,' published at Cincinnati in 1847, would have proved a useful guide for the traveller, but from Fort Hall to California there was no well-marked trail. Professor John Caughey has contributed a singularly lucid introduction to this reprint of Ware's 'Guide,' which he discusses in relation to the

numerous other guide-books printed in the following years, and concludes that Ware "was the first to attempt a complete description of the best route for the forty-niners."

In 1859 another gold rush took place, this time to a more accessible area than California. In the previous year a Delaware Indian, called Fall Leaf, arrived in Lawrence, a small Kansas town, and announced that gold had been discovered at the headwaters of the Arkansas River. At this date, in the words of Mr. C. L. Cannon, "the panic of 1857 still hung over the country like a pall. Conditions resembled those of 1932." The following sentences from Villard's book explain how striking is the parallel, and show that what statesmen of to-day call "an economic blizzard" overwhelmed the United States in the middle of the last century. "In the large cities a considerable portion of the working classes were still without employment, and hence in distressed circumstances. . . . The farming interest was still weighed down with the burden imposed by the failure of crops and debts incurred during the period of extravagance. . . . The prosperity they [the towns] had enjoyed previous to the general collapse of 1857 had been swept away by the fury of the commercial hurricane, real estate had depreciated, business was stagnant, debts remained unpaid, general bankruptcy was imminent." At such a time, the news of the discovery of gold stimulated large numbers of men to put all their belongings into handcarts and push their way across the 600 miles of the Plains to the foot of Pike's Peak. The *Cincinnati Daily Commercial* sent out a German, Henry Villard, to act as their correspondent during the gold rush. Villard had emigrated from Germany to New York in 1853, knowing no English, and it is remarkable that after only six years' experience of the language he was able to write 'The Past and Present of Pike's Peak Gold Regions.' The book was written in 1859 as a guide for emigrants, who might undertake the journey in the spring of 1860. Unfortunately for Villard, the printers went bankrupt, and as the book was published too late for the rush it was a financial failure. The book is valuable because it contains an account of the foundation of Denver and the surrounding towns. The gold rush of 1859 was the beginning of Colorado's prosperity, and the city of Denver's population reached the figure of 287,000 in 1930.

All the reprints are illustrated with maps and plates, reproduced from the originals. The books are well annotated with numerous bibliographical references, but the explanatory prefaces could have been lengthened with advantage. Partly as a result of the exchange, the present volumes are expensive. The reprint of Robinson's journal is a small book of ninety-six pages, while Ware's guide contains only sixty-four pages; in both cases the price is excessive. The four books should be useful to English students, who might otherwise be quite unable to obtain such rare volumes in this country, and it is to be hoped that the Princeton University Press will continue the series. E. W. G.

POLAR REGIONS

THE CONQUEST OF THE SOUTH POLE: Antarctic Exploration, 1906–1931. By J. GORDON HAYES. *London: Thornton Butterworth* 1932. 9½×6 *inches; 318 pages; illustrations and charts.* 18*s*

Dr. Hugh Robert Mill in his polar classic, 'The Siege of the South Pole,' has already shown quite clearly that it is not necessary—not necessarily even desirable—for a writer of polar history to have taken actual part in polar exploration. This view receives confirmation from the writings of Mr. Gordon Hayes on the same subject. The present book is a competent, well-balanced record of Antarctic

exploration since the great international attack of 1901–1904, which was the culmination of the period covered by Dr. Mill's earlier record. It is not written in a style comparable with that of the former book, but is nevertheless a sequel well worth while. The years 1906–1931 have seen great activity in the Antarctic as well as the Arctic regions, and one of the greatest difficulties of the historian is naturally that of compressing his account into reasonable compass without placing the emphasis on the wrong and relatively unimportant incidents. In this respect Mr. Hayes seems to the writer to have achieved a considerable measure of success. His selection from diaries has generally been judicious. Particularly good is the account of Shackleton's return from his attempt to reach the South Pole in 1909. The account of the southern journey of Scott's last expedition does not seem so adequate, but it is perhaps not the duty of the historian to inquire into the why and wherefore of the disaster. An opportunity was missed when he failed to use the schedule method—a method largely of his own devising—to compare closely the progress and times of Shackleton and Scott. Scott had with him on his fateful journey the diary of Wild, referred to elsewhere in the book, and the undue striving which produced the staleness on the return journey appears to the writer to have been largely caused by two factors not emphasized in Gordon Hayes's account—the psychological effect of the inevitable comparison he made between Shackleton's progress and his own, and the effect of the great summer blizzard in deeply shrouding the lower slopes of the glacier in soft snow.

To the reader particularly interested in polar science the omission of the proposed Appendix dealing with that subject will appear most unfortunate, especially as the main narrative is evidently written with the existence of this chapter in mind. Without it the emphasis on the geological discoveries of Gould in the Byrd Expedition, useful as it is as a comparison with Amundsen's failure to develop this aspect of his work, is liable to give an impression of similar lack of interest on the part of the British expeditions which in fact did an incomparably greater amount of geological work. This remark is not meant as a reflection on the work of Dr. Gould, who did all that was possible having regard to the conditions under which he was compelled to work.

The book is, thanks to the care with which it has been compiled and to the author's free use of criticism by living explorers, remarkably free from errors of fact. Mawson's air tractor sledge however originated, in the reviewer's belief, not as a deliberate attempt to employ this sort of traction, but as salvage from the wreck of an aeroplane. This belief is due to the vivid recollection of Wild's account of a fall of 130 feet during a trial flight at Adelaide and of a pilot whose only remark amongst the fragments of the wreck was "Poor old bus, she's broken up." On p. 256 the author, in suggesting that "living vestiges of earlier ages" might be preserved on the inaccessible ice-plateau of Graham Land, betrays his possession of an imagination that is elsewhere so well held in leash that he has proved himself a reasonably adequate successor to Dr. Mill as a polar historian, which is saying a great deal. R. E. P.

KABLUK OF THE ESKIMO. By LOWELL THOMAS. *London: Hutchinson & Co.* 1932. 9 × 5½ *inches;* 256 *pages; illustrations.* 10*s* 6*d*

Mr. Lowell Thomas, having made an English Intelligence Officer "King of Arabia" (uncrowned it is true), a German Naval Captain into a "Sea Devil" and a hero, now gives us the enthralling account of a French fur-store keeper and a Labrador Eskimo becoming David and Jonathan. Mr. Thomas has not included a map, which is just as well, as we should find that the "long Arctic night" took place some 600 miles south of the Circle, and that the "far North where oppor-

tunity beckoned" was in the latitude of Brighton. But of course we must remember that a lot has changed since the War. The aeroplane has "annihilated" distances, though this would seem almost too strong a word: for we find that the 350 miles from Missanabie to Moose Factory of Kabluk's day is still as much as 240 miles in spite of the aeroplane. What men they were, those strong travellers of the "great white silence"! Even the Eskimos were more masculine in those days, for they wore clipped pointed beards and could carry 700 pounds on their backs, though of course the white man had a far worse time, even getting snow blind in the summer from the sun's glare on the water. However, we find that they were far more competent than any one could pretend to be now, or at any rate David was, for did he not ride many miles on the back of Jonathan's kayak, and even go to sleep on it, without either falling off or upsetting it? The animals too were very different in those enchanted days before the War. Dogs ran with their tails straight out, instead of stupidly curling them up as they have since learned to do; walruses who now shyly browse a little seaweed, preferably away from mankind, then used to attack on sight "enraged with bristling whiskers and terrible tusks"; while musk oxen would then turn their backs to the enemy instead of facing outwards in the tame way they do now. As for natural phenomena they were then so terrific that one wonders how any one could have existed and lived to become Kabluk. The cold was so intense that, having left his hood off when he went outside the house, "his sight became blurred, his head spun dizzily and he fell heavily to the ground." If his Eskimo friend had not seen his plight he would not have been saved. Even the stars in those days were ice pointed, and as for the aurora, it was so extraordinary that "the edge of the luminous curtain passed overhead and burst into immense ribbons which formed gigantic convolutions with marvellous speed." Poor Kabluk! He returns to Montreal where he is "pushed and jostled by the passers-by who hurried on their way without giving him a single thought." However he returns to the North, having gone through the War, only to find disillusion; and, in spite of the tractors, motor boats, and aeroplanes, he came to "hate the North with its everlasting blanket of white snow and ice, its bleak rocks and crags, and its cruel insensate savagery," while even the flocks of birds flying overhead he found "disorderly." How he must long for the good old days when "Uyarak went out and brought back an icy gust," when ships "cast anchor"; those days in the North that now no longer is, the North that never was. A. C.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

DIE HYDROGRAPHIE DES KARSTES. By Otto Lehmann. (Enzyklopädie der Erdkunde. Edited by Oskar Kende.) *Leipzig und Wien: Franz Deuticke* 1932. 10×7 *inches;* xvi+212 *pages; illustrations and maps. M.*20

Originally a place-name the word "karst" is now used to designate areas in which the drainage is mainly subterranean, taking place in cavities developed within readily soluble rocks. Professor Lehmann's book is concerned with the origin, nature, and progressive development of this underground circulation, regarded mainly from the standpoint of the physicist. Karstic drainage occurs in limestone, dolomite, gypsum, and some calcareous marls, but it is an integral part of the author's argument that it is conditioned not merely by the solubility of the rock but by the presence within it of pre-existing spaces. These must be such as to permit both of the penetration of rain-water from above and of its passage without the blocking of its own course by redeposition of dissolved salts. Two types of cavity, he considers, must be initially present—large spaces whose diameter is of the order of metres, and smaller tubular spaces, joints, and fissures,

varying in diameter from some centimetres down to a minimum measured in millimetres. The whole system of spaces is of highly complex shape, often branched like a tree, built of elements of varying diameter and form, interlacing at all angles and with many bends on their courses. From the physical standpoint the whole has to be regarded as a water-filled vessel with an opening narrow in relation to its content. From this initial condition characteristic karstic hydrography is developed as a result of the solvent action of the entering rain-water, which leads to a smoothing out of the original distinction between wide and narrow spaces. The argument is directed to showing that it follows that what is sometimes regarded as the typical feature of karstic hydrography, the presence of an underground river within a large cave, is, on the contrary, the limiting case. "The true cave river with the dripping of water through the air of the unfilled spaces of the cave marks the implantation of the features of surface circulation below ground. It must be regarded as the degenerative stage of subterranean karstic drainage."

As a whole the book is scarcely intended for the geographer save in so far as he is also a physicist with a considerable knowledge of hydraulic phenomena, topics to which much space is devoted. It includes also however a number of detailed studies of the hydrography of particular karstic areas, *e.g.* of the great *polje* of Livno, based on personal observation. Thus while it is mainly a specialized treatise, without the general geographical appeal characteristic of most of the other members of the series to which it belongs, the book yet includes many incidental descriptions and discussions of much interest. There are a number of sketch-maps and diagrams, a certain number of illustrations from photographs, and a fairly extensive bibliography. Two indexes, one of authors and one of topics and place-names, are appended. M. I. N.

INSECT BEHAVIOUR. By EVELYN CHEESMAN. *London: Philip Allan* 1932. $7\frac{1}{2} \times 5$ *inches;* 190 *pages; illustrations.* 4*s* 6*d*

Miss Cheesman's little book is a lucid summary of the psychic forces that control insect behaviour. She has travelled widely, observed closely, and has in consequence a large store of original material on which to base her several conclusions. Opinion is certain to differ on these conclusions, but the observations she relates are incontestable facts and many of them are of great interest. She begins with an account of fossil insects, then passes on to simple reflex actions and the more complex instinctive behaviour. She shows clearly that instincts are not absolutely fixed, but have in them not a small element of variability; also that individual insects have particular forms of behaviour. Moreover she is satisfied that they have something higher than instinct; but she speaks of it as only an "awareness," meaning that the insect—and only the higher forms—live merely at the fringe of consciousness. Her conclusion that they have "reached the border between the sub-conscious and the conscious" is one with which all are not likely to agree. Some will say she has gone too far; perhaps only a few, like the reviewer, that she has not gone far enough. But in this matter facts are more important than conclusions, and those which Miss Cheesman here puts forward are likely to give both pleasure and instruction to persons interested in natural history.

R. W. G. H.

CARTOGRAPHY

CONFERENCE OF EMPIRE SURVEY OFFICERS, 1931. Report of Proceedings. Issued by the Colonial Office. (Colonial No. 70.) *London: H.M.S.O.* 1932. 11 × 7 *inches;* viii + 398 *pages; illustrations and maps.* £1

The 1931 Conference of Empire Survey Officers was the second of its kind to be

held. At the previous Conference in 1928 it is probable that colonial surveyors had not had sufficient time to bring forward their considered views on the problems which were of immediate interest to them. The result then, in this first Conference, was that the papers were largely contributed by well-known British surveyers and were mainly concerned with questions of geodesy, topographical survey, boundary delimitation problems, and such other subjects as fall naturally to the lot of Royal Engineer officers. At the end of the 1928 Conference it was agreed that the next meeting should concern itself more definitely with problems and subjects of a cadastral nature.

The Report of the 1931 procedures shows how fully this agreement has been kept, for the volume under review deals largely with property surveys, with questions of registration of title, and with kindred subjects. In this connection a Cadastral Exhibition was arranged by Sir Ernest Dowson, whose able speech at the opening of the exhibition is printed in the proceedings. It serves to emphasize the difficulties of land registration while surveys themselves are still in embryo and hence not yet in a position to undertake the revision of property surveys, and the importance of the close association between land survey and the geodetic framework. In addition an interesting paper by Sir Henry Lyons deals with land surveying from the earliest times. In African contributions it is made clear how the problems of registration of title are affected by the beginnings of the individual as an owner of property based on the example set in Transkei, instead of the previous tribal ownership and the special treatment which is demanded thereby. The reports and papers from the West Coast of Africa are of a uniformly high quality and emphasize how essential it is, even in these times of financial depression, that a nucleus at any rate of the departments of precise measurement and topographical survey should be maintained at all costs.

In addition, the Conference concerned itself, not unnaturally, with problems of the peculiarities of the Earth's surface and the recent developments of geophysics. The papers contributed by Sir Gerald Lenox-Conyngham and Dr. de Graaff Hunter in this connection are of particular interest. References to the arc of the 30th meridian in Tanganyika are rendered all the more poignant at the moment by the fact that it has been decided, from motives of shortsighted economy, to close down this most important work at a time when it is within sight of completion, and when the large capital outlay required to set the wheels in motion in the first place has already been expended. In any series of discussions on survey subjects there are bound to be a certain number of borderline cases, which, though not strictly analogous to survey, are of great interest and of necessity add to the variety of the book. Under such a heading fall papers on "The River Port of London," and "Time-keeping at Greenwich."

The book is well printed, the illustrations and diagrams are excellently clear. It is packed with a wide variety of survey matters and should be on the shelf of every survey library and in the hands of every young surveyor. This latter however is hardly capable of fulfilment, as the price of the book places it far out of the reach of shallower pockets. J. C. T. W.

ECONOMIC AND HISTORICAL GEOGRAPHY

THE DISCOVERY OF THE ANCIENT WORLD. By HARRY E. BURTON. *Cambridge, Mass.: University Press (London: Humphrey Milford)* 1932. 8 × 5½ *inches; 130 pages; sketch-maps.* 8*s*

This short sketch of discovery from the Ancient Egyptians to the Romans is intended primarily to assist readers of classical texts. The author must therefore be pardoned if at times he labours points which are commonplace to students of

the subject. He states in his preface that he has "in general studiously avoided the discussion of disputed points," a cautious attitude which deprives his work of considerable interest. The bulk consists of analyses of the works of classical geographers, and indications of the source of their knowledge. Some more attention might have been given to the important "silk route" from China; nor does there appear to be any mention of Ophir. Within its limited scope the work is carefully done, clearly written, and provided with a useful bibliography.

G. R. C.

PROBLEMS OF POPULATION: being the Report of the Proceedings of the Second General Assembly of the International Union for the Scientific Investigation of Population Problems, held at the Royal Society of Arts, London, June 15–18, 1931. Published under the direction of the Executive Committee. Edited by G. H. L. F. PITT-RIVERS. *London: George Allen and Unwin* 1932. $9^{1}/_{2} \times 6$ *inches;* 378 *pages; diagrams and map.* 15*s*

The World Population Conference, held at Geneva in 1927, led to the formation of the International Union for the Scientific Investigation of Population Problems, to which twelve countries were adherent in 1931. The report of the Second General Assembly of the Union shows that a considerable measure of co-ordination has been established in the investigation of problems of population, and that a marked change has taken place in the way in which the general outline of the main problem of population is regarded. The prevalent opinion, as late as 1928, was that of East and Knibbs: that the population of the world was increasing at rates that would lead to congestion before the end of the century. Now however it is believed, whether from forecasts based on the assumption of a logistic law of growth, or from those based on future rates of birth as indicated by the present age distributions, that a slackening of growth, followed perhaps by an actual decline in numbers, is likely to take place in the United States, Belgium, Germany, France, and England, before the end of the century. Interest is now shifting to the closer study of the quality of population, and to the social and economic conditions in which people live. The Report is one that human and economic geography cannot afford to ignore. Apart from the fact that it presents a summary statement of the world's best opinion on a major problem, it contains three geographical papers, and an experimental map in colour, showing the distribution of the population of Hampshire and the Isle of Wight in 1921. Captain J. G. Withycombe's paper explains the map. Professor C. B. Fawcett's paper is a brief but most useful presentation of the geographical considerations of area, density of occupation, and production, which underlie the whole problem of population. The third paper, by the late Professor J. W. Gregory, deals with "Some effects of current migration restrictions." The reports, at the end of the volume, of several commissions appointed by the Union, should not be overlooked. The discussion of all papers has been printed, and an English summary is given for papers appearing in German and French.

M. A.

Sir Charles Close has kindly sent us the following note on the contents of this volume:

It becomes more and more clear from a study of these papers that no one group of scholars can deal adequately with the problems involved. Without doubt place must be found for the biologists, for the economists, for the sociologists, for the anthropologists, and we must not forget the statisticians. In this Society we are not at all likely to ignore the important contribution that geography can bring to the discussion of population; and in return we shall not forget the important

part that such scientific discussions as those in the volume under review can take in shaping some of our ideas in the study of the world as the home of man.

For those mathematically inclined the drawing of population curves has a genuine fascination, and also the investigation of the structure of populations, particularly the age structure. For instance, Professor Bowley shows that in 1921 for every hundred men in Great Britain of working age—that is, between 15 and 65—there were in that year about 90 boys and girls under 15, and 19 men and women over 65. He makes the approximate calculation, if existing tendencies persist, that, in 1951, there will only be 60 boys and girls under 15, whereas there will be 32 men and women over 65. A somewhat similar result, though expressed in different ages, is arrived at by Professor Whelpton for the United States. Both estimates show a marked ageing of the population. The latter authority puts the matter like this: "Persons in the prime of life for physical work—20 to 49—were over three times as numerous in 1930 as those 50 to 69; but by 1980 the ratio will be less than two to one." And he draws important conclusions in the economic and political spheres from this forecast.

GENERAL

A REGIONAL GEOGRAPHY OF THE WORLD FOR SCHOOLS. By JOHN BYGOTT. *London: University Tutorial Press* 1932. $7\frac{1}{2} \times 5$ *inches;* x+362 *pages; maps.* 4*s* 6*d*

This is a very disappointing text-book. It contains the usual facts considered necessary for the General School and Matriculation Examinations in Geography, but no more. It is claimed that the book is written on modern lines and that fifty-four original diagrams have been specially drawn for it. These diagrams are almost completely useless. They seldom show relief or drainage and consist of outlines of countries or continents with letters (denoting climate or products) scattered over them. The climate maps on pp. 10, 11, and 13 are quite unintelligible. These diagrams conform to a type which was superseded twenty years ago. The useful maps are those which are not original.

Several old text-book errors are repeated, and there are numerous mistakes both of spelling and of fact, one being the placing of Amiens instead of Antwerp in the map on p. 116. Nowhere does one obtain a comprehensive view of a continent as a whole, in its aspects of relief, climate, vegetation, and natural regions in their logical order. We cannot regard this book as an advance on the many matriculation text-books already on the market. A. B.

GREAT TRAVEL STORIES OF ALL NATIONS. Edited by ELIZABETH D'OYLEY. *London: George G. Harrap & Co.* 1932. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* 1030 *pages.* 8*s* 6*d*

MODERN EXPLORATION, SPORT AND TRAVEL. By NORMAN J. DAVIDSON. *London: Seeley, Service & Co.* 1932. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* 318 *pages; illustrations.* 18*s*

The compiler of the first anthology of travel has not worried too much over the problem of what constitutes a great travel story. Her aim has been both to thrill and to amuse. Consequently she has given rather more weight to personality and literary style than to actual scientific achievement. Thus Horace, Heine, Stevenson, and H. M. Tomlinson appear in the company of Marco Polo, Mungo Park, Humboldt, Nansen, and Scott. Almost all the names one would expect to find are included, with a sufficient number of lesser lights to supply an element of surprise. Where one aim has been to include representatives of as many nationalities as possible, a uniform standard throughout has naturally not been

achieved. Two recent explorers are missing—Amundsen and Shackleton. The latter has perhaps been included in the companion volume of sea stories. Australia is hardly treated adequately, and the unfortunate ending of the Burke and Wills expedition might well have been left out in favour of Sturt, or Eyre, or McDougal Stuart.

The English and American sections, the longest in the book, have a certain unity: the former from the extent to which the Near East, and particularly Arabia, is the scene of action. The latter is united around the theme of the westward advance of the frontier. The book is a most excellent introduction to the literature of exploration, and leads the reader to turn largely to the original works. It is published at a very reasonable price, and should certainly be in every school library.

The second book has not so much to commend it. The travellers included hardly justify the comprehensive title. It consist of précis of half a dozen or so works issued recently by the publishers—which smacks rather of mere book making: those readers likely to be interested will probably prefer to go direct to the originals. The chapters range from life among the Eskimo to big game hunting in Africa. G. R. C.

FROM JUNGLE TO JUTLAND. By Major CLAUDE WALLACE. *London: Nisbet & Co.* 1932. 9 × 5½ *inches;* xii + 344 *pages; illustrations and sketch-maps.* 16*s*

Major Wallace was sent out in 1913 as a young man by a well-known manufacturing firm to survey and report on the unexplored hinterlands of Liberia, the Ivory Coast, Nigeria, and the Congo. Although he says that his work was not superficially so exciting as hunting the lion and the leopard, it must be admitted that his quests resulted in far greater variety of excitement and adventure than falls to the lot of the average big-game hunter. As the guest of a cannibal chief he witnesses the trial of a malefactor by witch-doctors and his preparation for the dreadful death of being devoured by ants. He narrowly escapes death by fire, flood, famine, wild beasts, and hostile negro tribes.

At the outbreak of war he returned to serve in France. Guided by the premonition of a great naval battle, he obtained leave to visit Scapa Flow, where he joined the Fleet on the eve of the Battle of Jutland. As an untrammelled observer in the maintop of the battleship *St. Vincent* he got an excellent view of the battle. In face of the overwhelming evidence to the contrary, it is difficult to accept his observations on the tactics employed by the Battle Cruiser Force at one of the most crucial phases of the action; but his position as an independent witness, and the account of his interviews with Lord Jellicoe and Lord Balfour immediately after the battle, make this part of the book interesting reading. A. D. L.

THE PRACTICAL OUTLOOK GEOGRAPHIES. By GEORGE T. MCKAY. *London: Blackie & Son* 1931–32. 8 × 5 *inches.* Book III. The British Isles. 206 *pages.* 2*s* 3*d*. Book IV. The World. 222 *pages; illustrations and maps.* 2*s* 5*d*

This is the fourth volume of a series of Preparatory Geographies intended as an introduction to the study of geography in schools beyond the junior stage. As such it is probably much too difficult. The discussion of "the form and pattern of the earth" is beyond the comprehension of junior pupils. Too much space for so small a book is devoted to the study of a volcanic region, the making of a relief model, and the manufacture of a model loom. The chapters dealing with the major climatic regions are well done and well illustrated, but it should be noted that the statement that polar bears hibernate (p. 85) is too general; only

the female hibernates. Again (p. 172) the statement that the only way to grow tea is on terraced hillsides is not correct: in these days much tea is grown on plains, the excess of water being removed by skilful drainage. E. Y.

A MODERN GEOGRAPHY. By S. EVELYN THOMAS. *St. Albans: The Donnington Press; London: The Gregg Publishing Co.* (1932). 9×6 *inches*. Vol. I. General and Physical Geography. x+160 *pages*. 3*s*. Vol. II. Economic and Regional Geography. xii+161–818 *pages*. 9*s* 6*d*. *Maps and diagrams*

There is an inconvenient difference in thickness between the two volumes of this large text-book, and the pagination runs on from the first to the second volume. Apart from the fact that Vol. II contains an immense amount of statistical information which is up to date, it is not clear in what sense the work is to be regarded as modern. The author has taken pains to compress the whole subject into his book, and in Vol. I the result, particularly in the meteorological sections, is that the explanations of phenomena and of principles are too brief to be satisfactory. Vol. II is a useful compendium of reference, assembling information that is not so readily available elsewhere within the covers of one book. Many of the diagrams are ingenious and interesting, particularly those showing the situations of important cities (though such terms as site, situation, position, are used indiscriminately), and the occasional originality of the book makes it one well worth the attention of teachers. It certainly succeeds in reflecting the contemporary economic conditions of the world, which was one of the author's primary intentions. M. A.

TRISTAN DA CUNHA: an Empire outpost and its keepers. By DOUGLAS M. GANE. *London: George Allen and Unwin* 1932. 8×5 *inches;* 174 *pages; illustrations*. 7*s* 6*d*

Mr. Gane having been largely responsible for directing attention to the problem of Tristan da Cunha, his views upon the island's future demand particular attention. Some idea of both sides of the case for evacuation may be gleaned from this most interesting work, though the author naturally does not disguise his enthusiasm for its retention as a part of the Empire. The disadvantages are remoteness, lack of natural resources, dangerous increase of population, and a certain lack of initiative. Against these must be set the repeated refusal of the community to abandon the island, their physical and moral well-being, the possible strategic value of the settlement, and reasons of sentiment. Whether the island is likely to become once more of use in rescuing shipwrecked crews appears doubtful. Most readers will agree with Mr. Gane that individual migration to South Africa, under careful supervision to prevent the migrants becoming merely "poor whites," is the best solution of the overcrowding. The problem resolves itself into the possibility of maintaining communication with the Cape in both directions. G. R. C.

THE MONTHLY RECORD

THE NORWEGIAN EXPEDITION TO THE ANTARCTIC

A Norwegian expedition, under Captain Riiser-Larsen, which is now on its way to the Antarctic, is of particular interest, not only because it will be breaking new ground, but also because it is planned on an unusually small scale as to personnel, and proposes to use methods quite new on the Southern Continent. The leader has had several summers' experience of the Atlantic sector of the Antarctic, though he has not yet spent a winter there, and during his discovery of certain new sections of the coast-line he was impressed by the difficult character of the land-ice slopes from the point of view of sledge travel. He realized that to travel along on the land-ice, as was done by some of Sir Douglas Mawson's parties in 1912–13, would be a slow and somewhat risky venture. He therefore conceived the idea of using the sea-ice off the coast for his sledge route, with the added advantage that seals and penguins would thus be close at hand for food.

The plan is not precisely new, since it was the basis of more than one project in the past, which came to nought for lack of funds. Dr. Mackay, of the Shackleton *Nimrod* Expedition, for instance, once suggested this method of travelling from Graham Land to King Edward Land. Nevertheless the plan is a bold one, for whenever the sea-ice breaks away in the Antarctic it tends to drift northwards and westwards away from the land. At best this would involve travelling from floe to floe over the pack-ice to reach land again; at worst it would mean drifting to warmer waters, where the pack is slowly dissipated. There are times of the year when sea-ice travel along such a coast would be a reasonable, if not exactly a safe method. There are other times, such as from January to April, when, unless there were a large mass of pack-ice beyond the belt on which travelling was done, it would be very dangerous. Few men can have a better acquaintance with the Antarctic pack-ice than Captain Riiser-Larsen, and we can rest assured that he appreciates the hazard of the task. To meet the contingency of being adrift on the ice, he has designed special covers for his sledges which will convert them into boats. He is also taking a wireless transmitter, with which he can keep in touch with the ships in the Southern Ocean. His companions, Hallvard Devold and Olav Kjelbotn, have both had considerable experience with dogs and sledging methods in Greenland.

The party of three men and some sixty dogs will be landed from a whale-catcher somewhere to the west of Enderby Land in February, and this being a dangerous season for sea-ice travel, the party will probably make a temporary base on land, somewhere in the vicinity of the bay discovered and named Ice Bay by Riiser-Larsen himself, an interesting inlet between Enderby Land and Queen Maud Land. As soon as the sea-ice appears to be safe, the party will drive along the coast in a westerly direction, the first 300 miles having already been observed from the air by Riiser-Larsen himself on flights from the *Norvegia*. Between Queen Maud Land and Princess Ragnhild Land there is a gap on the map, occupied, it is thought, by a deep bay; and it will be the object of this party to explore this as well as time permits. Princess Ragnhild Land has also been observed from the air, but beyond long. 25° E. there is a vast gap of some 600 miles or so, entirely unknown, until Crown Princess Martha Land is reached, which links on to the British discoveries on the east side of the Weddell Sea. The rate of progress over this first part of the expedition's route will depend partly upon the safety of the ice, but still more upon the weather.

There is every reason to suspect that this stretch of coast will suffer from the tremendous blizzards from the Plateau, which are such a characteristic of the coast-line explored by Mawson south of Australia. The large temperature

gradient between the ice-covered land and the sea must render the weather uncertain, and probably on many days it will be impossible to travel. There can be no difficulty about food, since seals and penguins will be met with almost anywhere along this stretch, inhabiting the sea-ice. Towards the end of May however the animal life will not be so easily found since the Weddell seals tend to stay in the water, so much warmer than the air at that season, and the penguins go north on the pack-ice. It will therefore be necessary for the party to make a halt for the winter in some place where there is security from being blown out to sea, and sufficient supply of seals. With reasonable good fortune this winter halt should be made between the Greenwich Meridian and 20° E. As soon as the light gets good enough for travelling, and seals are to be found on the ice, the party will start off again, probably in August, and proceed westwards once more. At Cape Norvegia in Crown Princess Martha Land they will have reached a charted coast, and will pass down it towards the head of the Weddell Sea.

Captain Riiser-Larsen hopes to penetrate to Filchner's farthest point in 1912, but it is possible that he will take a short cut from somewhere near the Stancombe-Wills Ice Tongue in 74° S. across the Weddell Sea to the particularly interesting gap from 40° W. to 60° W. It is possible however that the moving pack-ice in the centre of the Weddell Sea will afford worse travelling than the longer route round the coast. The pack-ice in the Weddell Sea is less risky than that in the earlier part of their journey, for the drifts of the *Deutschland* and the *Endurance* show that the movement northwards is slow and intermittent.

Presumably this coasting of the Weddell Sea will be done during the period August to December of this year, and it depends upon their rate of progress as to whether the party will have difficulty in reaching their depot at Hope Bay on Louis Philippe Peninsula. The Graham Land Archipelago is fairly well known from Wilkins's flights, but after January the ice may well have broken up for the last 200 miles of their journey, and enforce upon them a halt on the south-east side of the Archipelago. On the other hand, with their wireless they may get into touch with whale-catchers, and be relieved in the vicinity of Snow Hill Island, should the sea be open.

It will be seen from the above account that beyond the monotony and ordinary incidents of sledge travel the chief risk to be run will be in the movements of the ice on which they are travelling, and these will be most important during the first few months of their journey. Food should never be lacking, but the health of the dogs and of the men with so small a party will naturally be a concern to the leader. If accomplished, the journey will have filled in, in the most thorough way possible, nearly one-third of the outline of the Antarctic Continent. The plan, although bold, cannot be called rash, and all the ordinary risks have been foreseen and allowed for. It is the first long journey of this nature to be attempted in the Antarctic, second only in enterprise to the late Mr. Watkins's plan for crossing unsupported from the Weddell Sea to the Ross Sea. This journey is a much longer one than that planned by Watkins, but it traverses areas with ample food supplies. F. D.

RECENT RESEARCH IN METHODS OF CHRONOLOGY

In a paper (Publication 3152, 1932) published by the Smithsonian Institution, Washington, D.C., and entitled 'Research Corporation Awards to A. E. Douglass and Ernst Antevs for Researches in Chronology,' these two authors give a very readable and useful account of the methods of chronology based on tree rings and varve clays. The paper is not an exhaustive treatise on these subjects, but it gives in small space the main outline of the researches carried out by these two workers. Douglass shows how the measurements of the rings, especially in the

giant trees of the western United States, afford a sound basis for obtaining relatively exact dating. He further outlines the ways in which tree rings show cycles of climatic fluctuation corresponding with sun-spot and other periods. He then goes on to show how trees in neighbouring areas can be correlated, and also how beams from ruins can be utilized so as to bring the dating of archaeology into line with that of tree growth.

Antevs outlines the methods, first propounded by De Geer, of dating by means of varve clays. In a short but very lucid account he explains how varve clays are deposited in glacial lakes, and summarizes the methods employed in the field and laboratory for their correlation. He also shows clearly how they are related to the gradual recession of the ice-margin. He refers briefly to the connection between the ice-sheets of North America and Europe, but states that correlations between them are not yet possible. "However, a correlation of the late glacial epoch on North America and Europe may be made on the basis of the major changes of temperature that are recorded in the rate of disappearance of the ice sheets."

For a statement of the two main problems and their complexities, these two short papers, written by experts, give a valuable summary. To field workers in these problems they may contain little that is new, but to the student or to the general reader they give just what is required. J. A. S.

THE OXFORD UNIVERSITY EXPLORATION CLUB

The fourth annual report of this club, for 1931–32, shows it to be in a flourishing condition. Since its foundation in 1928 it has maintained an unbroken series of expeditions of which three have been to the Arctic or the fringe of the Arctic and two to the tropics, including that of 1932 to northern Sarawak. For this year expeditions are being projected to Spitsbergen, Abyssinia, and the New Hebrides. The present report consists chiefly of an illustrated account of the Hudson Strait expedition of ten members, under Mr. H. M. Clutterbuck's leadership, who explored and mapped Akpatok Island in Ungava Bay in August and September 1931. At the time this island was practically unknown and offered several problems of interest. The leader contributed a paper on the work of the expedition to the *Geographical Journal* of September 1932, and another member has published a personal narrative in book form (see *Journal*, February 1933, p. 180). It is proposed to collect various papers dealing with the results into a single volume in due course. The expedition was financed by its members with help from some Oxford colleges, the Royal Society, and this Society, while an opportunity to earn freight in carrying certain stores for the Hudson's Bay Company covered many outlays. Two other aspects of the expedition merit notice. Bears were seen in large numbers and proved, as usual, inoffensive, but other animals were very scarce. A few seals and no walrus were seen. Guillemots on the cliffs at the northern and southern ends of the island were numerous, and ptarmigan were not too rare to provide some fresh food. Fish were scarce round the coasts. The bears with one exception were unmolested but noted as a possible source of winter food if the expedition should be stranded. A reference to the loss of C. J. D'Aeth may be quoted for the moral it conveys. "Bad luck and bad weather were directly responsible, but the primary reason . . . was the abnormally fine weather experienced during the preceding weeks, with high day and night temperatures. With such conditions continuing far into September, it became increasingly difficult to convince the younger members of the expedition that these weather conditions were unusual and could not continue indefinitely." In short, it is fatal to be unprepared for rapid changes in weather in Arctic regions.

R. N. R. B.

THE SUBSIDENCE OF LONDON

In reference to the note in the Record, *Geographical Journal*, January 1933, upon Ordnance Survey Professional Paper No. 14 (New Series), "The Subsidence of London," Colonel Sir Charles Close writes that there is an important point that the author seems to have missed. "The Second Geodetic Levelling of England and Wales has a mean date of January 1916, and, when the heights as given by this levelling are compared with those of the original levelling of mean date January 1850, it is found that the new values south and east of Liverpool are all lower, and become increasingly lower as the south and east coasts are approached, the greatest difference, of about 1·75 feet, being in the neighbourhood of Felixstowe. But this evidence cannot be taken at its face value, because the old levelling had not a very high standard of accuracy. As a fact, as early as 1859 a difference of 1·88 feet was found between the actual mean sea-level at Harwich and the mean sea-level derived from Liverpool by the levelling. One cannot therefore agree with Captain Longfield when he says that there was no proof that a large cumulative error existed in the old work. It was indeed on account of the evidence of cumulative error that the suggestion was turned down, in the 'Report on the Second Geodetic Levelling,' that we could assume any general downward tilt of this country in a N.W. to S.E. direction. So we must rule out this bit of evidence."

SEVENTEENTH-CENTURY TRAVEL IN ENGLAND

A bibliography of this subject is given by Messrs. G. E. Fussell and V. G. B. Atwater in *The Library* for December 1932. It does for the seventeenth century what had already been done for the eighteenth in the same periodical for June 1929, and the two papers together, though making no claim to completeness, form a useful guide to the available literature, both English and foreign, describing the English countryside and its people from the Elizabethan period to about 1800. Many of the items are not generally known, and are not found in the R.G.S. Library, which is far from strong in this class of books. To some extent the second list covers the same ground as the bibliography appended to Miss Joan Parker's 'Travel in England in the Seventeenth Century' (1925), though one or two of the titles in the latter, which we might expect to find in a list of the kind, are missing from the present one. An instance is H. Misson's 'Memoirs and Observations,' published in English in 1719, but belonging in the original French to the previous century. On the other hand a good many items are to be found in the later list only. The authors have wisely adopted a chronological arrangement, the position of the items being determined by the period to which they refer, and not by the date of publication, for the reference in many cases is to modern reprints. It is not always made clear whether such modern issues are from previously unpublished manuscripts or from scarce printed works, for occasionally the earliest printed version is not quoted, while in one case at least—that of the 'Relation of a Short Survey,' 1634, of which a new edition appeared in 1904—only an earlier reprint (that of 1849) is quoted. The list goes back to the late sixteenth century and includes such works as Norden's descriptions of Middlesex, Herts, etc., but we find no reference to Lambarde's very similar 'Perambulation of Kent,' 1576 and 1596. Some judicious remarks on the different classes of travellers whose works are of value as sources of social and economic history precede the list proper.

LOESS IN EUROPE

Although the vast deposits of north-east Asia are generally regarded as the most typical examples of loess formation, those of Europe have a considerable extent, stretching in a nearly continuous zone from Northern France to Russia.

The problem of loess-formation is not yet completely solved, and a good deal can be learnt from a detailed study of its distribution, such as has been undertaken by Rudolf Grahmann in the *Mitteilungen* of the Leipzig Geographical Society, vol. 51, 1932. The paper is illustrated by three maps, one showing the general distribution in Europe, another that in Central Europe, in more detail, and the third that in the Free State of Saxony. In compiling them the author has made use of all the material available, including some unpublished MS. maps placed at his disposal. In the text he discusses in turn the distribution, composition, and structure, origin, etc., of the loess deposits, and ends with a concise summary of conclusions. In the zone of its occurrence loess fills nearly all the depressions and plains, forming a belt between the North German lowland and the foot of the Mittelgebirge. Unlike Berg, whose views were summarized in the January number, p. 90, Dr. Grahmann considers its character as a sub-aerial deposit, closely connected with the glacial periods, as beyond question, and he discusses fully the climatic conditions—aridity, prevailing winds, and so forth—to which its formation was due. He adopts the view that the preponderance in its structure of grains of a more or less even size (between 0·05 and 0·01 mm. in diameter) is a result of the combined action of water and air transport, by which larger grains are eliminated, an important source of supply being the finer sediments spread over the surface by flood-waters, and not only the moraines of the northern ice-sheet or the Central European glaciers. The climate of the Ice Age was marked by dry northerly winds in summer and cyclonic snow-bringing west winds in winter, thus fulfilling the requisite conditions for loess-formation, which are held to be (1) regular dry periods with constant winds; (2) production and transport of fine material from areas not covered by vegetation. It is suggested that the differing types of loess in Eastern Asia and in Europe should be known as "Continental" and "Glacial" respectively, the sifting of material in the former region being by wind only.

IRRIGATION IN SHENSI

The scanty rainfall of the north-west provinces of China, the yearly average of which is for the most part not above 12 to 14 inches, while it may fall as low as 6 inches, makes agriculture a precarious resource at all times, while a failure of even this small amount quickly entails a famine. Only the porous nature of the loess and red clay of the region makes any extensive agriculture possible. Irrigation, which might improve matters, is not favoured by the physical conditions, though history tells of old irrigation works long fallen into disuse. One such was in the Wei Pei district, where the King river, a tributary of the Yellow River through the Wei, was brought into play. Steps to restore this have been made within the past two years under the joint auspices of the International Famine Relief Commission and the Shensi Government, and are described by two of the engineers in charge, Messrs. Eliassen and Todd, in the *China Journal* for October last. The area affected lies north of the King river, after its exit from the mountains, where a dam has been built to turn the water into the irrigation channels. But the river brings down such an enormous quantity of silt when in flood (as much as 46 per cent. by weight has been recorded) that nothing like a storage reservoir is possible, and the only practicable course has to exclude the water from the system at the worst periods, the intake having the form of a tunnel cut in the rock, which can be closed tightly by gates. Two main canals have been dug, each branching into secondary distributories, and it is thought possible to irrigate in this way 85,000 acres.

EIGHTEENTH-CENTURY ARTISTS IN INDIA

We have received from the editor a copy of *Walker's Quarterly* (No. 35–36) which contains an account of the work of the artists Thomas and William Daniell by Martin Hardie and Muriel Clayton. The Daniells were among the earliest of the band of English artists who at the end of the eighteenth century began to exploit the scenes and architecture of India for wealthy Anglo-Indian patrons. This account deals with their work in general but also contains a condensed version of the diary kept by William Daniell during their visit to India in 1786–94. After working for some time at Calcutta, they made an extensive journey into the interior, visiting Benares, Cawnpore, Agra, Delhi, and Hardwar. Thence they paid a short visit to Srinagar, which city they erroneously thought they were the first Europeans to visit. Later they went south to Madras and Trichinopoly, but were somewhat hampered by the unsettled state of the country. The diary is commonplace in style and material, but by its very casualness throws light upon the then conditions of travel in India. On returning to England they began to publish a series of aquatint views in their *Oriental Scenery* from 1795–1808. These met with great success, for Indian art was then in vogue. To this was due the architectural style of the Pavilion, Brighton; the architect, Humphrey Repton, having discovered in Daniell's drawings "new sources of beauty and variety, which might gratify that thirst for novelty so dangerous to good taste in any system long established."

MUD STALAGMITES IN INDIANA CAVERNS

In *Amer. J. Sci.* for January 1933 Messrs. C. A. Malott and R. S. Shrock give an account of a type of stalagmite, not, they believe, hitherto described, which they discovered during the summer of 1929 whilst exploring the underground system of Lost River in the karst country of Indiana. The formations, composed of a heavy clay silt having the consistency of rather stiff mud, appear only on mud slopes along the sides of certain caverns in which flood waters from heavy rains take a considerable time to subside. They vary in size from small circular welts about holes formed by drops of water successively falling on the mud banks, to cylindrical columns 18 inches in height and 6 inches in diameter, and their form, even to the crenelated surface, closely resembles that of normal stalagmites composed of carbonate of lime, except that there is a round hole or pit in the top of the column about half an inch in diameter and 1 to 4 inches deep.

Whereas normal stalagmites are formed by a chemical process, the origin of the mud forms is purely mechanical. When the little pits have been initially made by drops falling from the roof of the cavern a flood comes which causes them to be filled with silt left by the slow subsidence of the ponded waters, and after the withdrawal of the latter the falling drops splash out from the pits most of the silt, which then accumulates around them as a welt or ridge, so that by repetition of the process the column of mud grows. The stalagmites were found to occur both isolated and in closely packed groups, to be nearly structureless internally and to contain no carbonate of lime except in the case of those produced by water dripping from ordinary stalactites. In the latter case the stalagmites almost invariably had an inner core of lighter coloured material of about the same diameter as the pits at the top, extending the whole length of the columns and consisting to a considerable extent of calcite or other form of carbonate of lime.

Mention is made of another kind of abnormal stalagmite that is known, namely, the lava stalagmites found in certain lava caverns.

MEETINGS: SESSION 1932–1933

Sixth Evening Meeting, 23 January 1933. The President in the Chair

Elections: James Benson Bamford; Alfred Philip Bean; Captain Thomas Yates Benyon; Major Eric John Swithin Bonnett, M.R.C.S., L.R.C.P., D.P.H., R.A.M.C.; Edward Noel Bowman; Major R. Llewellyn Brown, R.E.; Joseph Gladstone Butcher; Arthur Frederick Cobb, B.A.; Captain Cyril Francis Coley; Mrs. Mary Daniell; Peter Falk; Henry S. Hall, Jnr.; The Rev. John Hall, TH.L., F.R.E.S.; The Rev. George Hopper; Charles Keith-Morris; Foster Stearns, M.A.; Arnold James Stuart; Lieut.-Commr. A. Townsend, R.N., F.Z.S.; George Vaux

Paper: Ruwenzori: Flights and Further Explorations. By Dr. Noel Humphreys

Seventh Evening Meeting, 6 February 1933. The President in the Chair

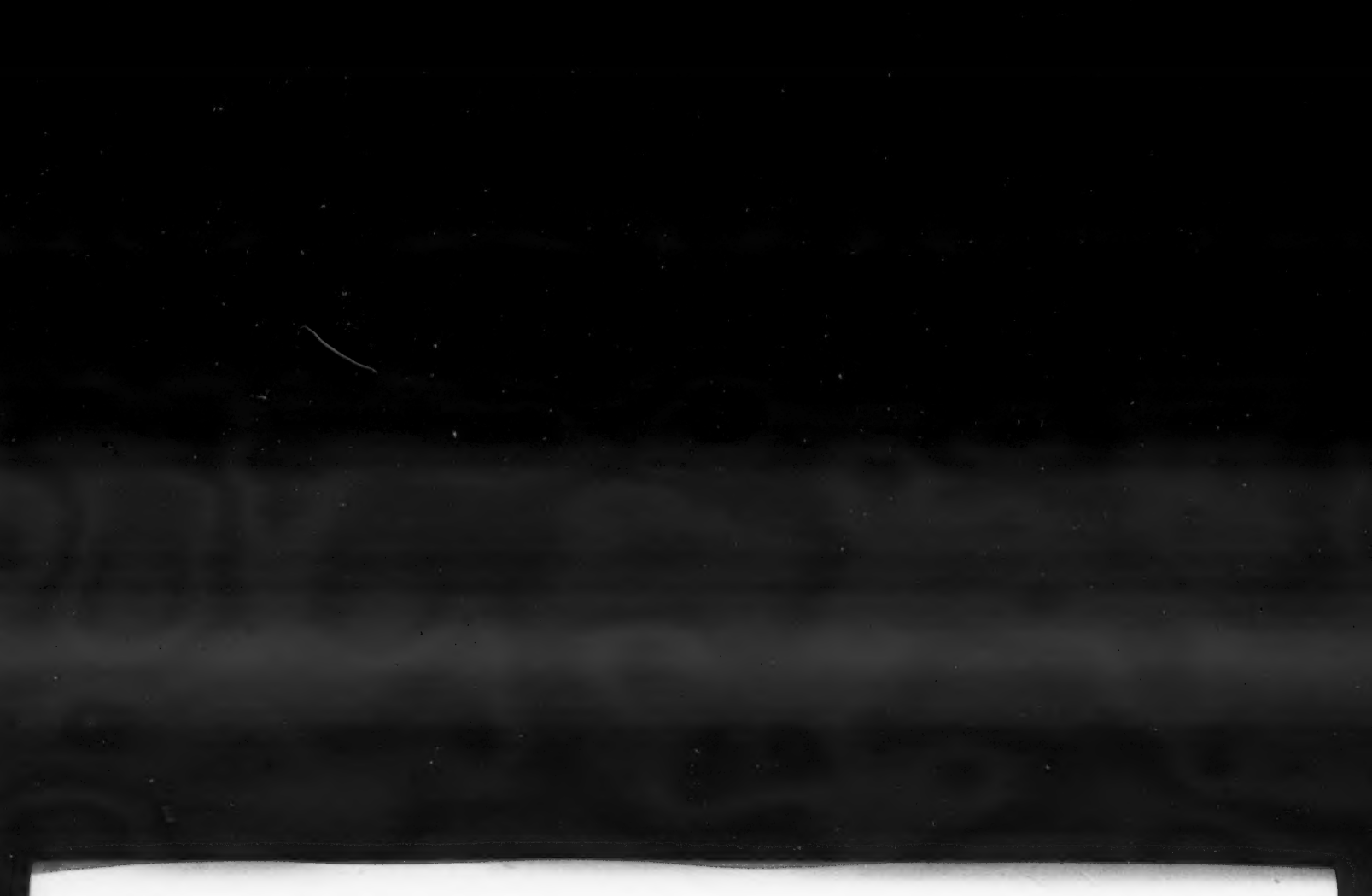
Elections: Captain Alfred Oscar Minter Cooper; Walter Fogg; Claude Albert Jones; Captain F. Maxwell-Lawford, M.B.E.; Captain Walter Parker Moffoot; John Pearson Pearson; William Charles Primmer, B.A.; William Riley Taylor; Alfred Robert Taylour, M.A.; Frederick James Williams, M.B., B.S., F.B.E.A.

Paper: The Blosseville Coast of East Greenland. By Captain Ejnar Mikkelsen

Fourth Afternoon Meeting, 13 February 1933. The President in the Chair

Paper: The Urbanization of the Shetland Islands. By Mr. A. C. O'Dell

Eighth Evening Meeting, 20 February 1933. The President in the Chair

Elections: Leon Boehm de Sauvaune; James Caisley; John Bonus Child; Herbert Melville Churchill; Clyde Eddy; James Pagan Fraser; Arthur Gough; Miss L. Knowles; Robert Brian Leighton; Robert Miles Milbank Christian Orpwood; Charles Packwood; Denis Keith Flowers Palmer; Capt. William Juxon Pearce, R.C.S.; Colonel Edward T. Peel, D.S.O., M.C.; Capt. John Robinson; Miss Freda Troup

Paper: The Namuli Mountains, Portuguese East Africa. By Mr. J. Vincent